Programmable synthesizer / function generator 0.1 mHz – 2 MHz

PM 5191

9445 051 91001

Service manual

9499 455 00111
87 09 01

I&E
Industrial & Electro-acoustic Systems Division

PHILIPS
Industrial &
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PHILIPS

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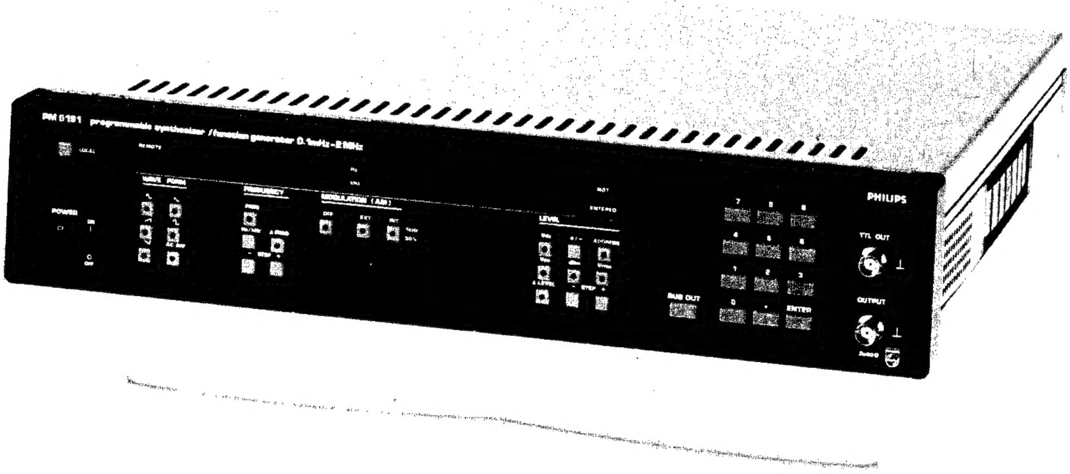

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Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s. v. p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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1. SAFETY INSTRUCTIONS

> WARNING:
> These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other then that specified in the Operating Instructions unless you are fully qualified to do so.

Read these pages carefully before installation and use of the instrument.

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition.
Adjustment, maintenance and repair to the instrument shall be carried out only by qualified personnel.

1.1. SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.2. CAUTION AND WARNING STATEMENTS

CAUTION:
Is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

> WARNING:
> Calls attention to a potential danger that requires correct procedures or practices in order to prevent personal injury.

1.3. SYMBOLS

	Protective earth (grounding) terminal	(black symbol on yellow background or impressed, e. g. at the mains connector at the rear)

1.4. IMPAIRED SAFETY-PROTECTION

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. The matter should then be referred to qualified technicians.
Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.5. GENERAL CLAUSES

> WARNING:
> The opening of covers or removal of parts, except those to which access can be gaines by hand, is likely to expose live parts and accessible terminals which can be dangerous to live.

The instrument shall be disconnected from all voltage sources before it is opened.

Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

> WARNING:
> Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous.
> Intentional interruption is prohibited.

Components which are important for the safety of the instrument may only be renewed by components obtained through your local Philips organisation (see also chapter 9.).

After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in chapter 9 have to be performed.

1.6. CONNECTIONS

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitors. By this means hum loops are avoided and a clear HF earthing is obtained.

If the circuit earth potential in a measurement set-up is different from the protective earth potential, it must be noticed,

- that the BNC sockets can be touched and that it must not be live, see the safety regulations on the subject (VDE 0411),
- that all sockets marked with the sign ⊥ are internally interconnected.

2. MAINS VOLTAGE SETTING AND FUSES

The safety instructions in previous chapters must be followed.

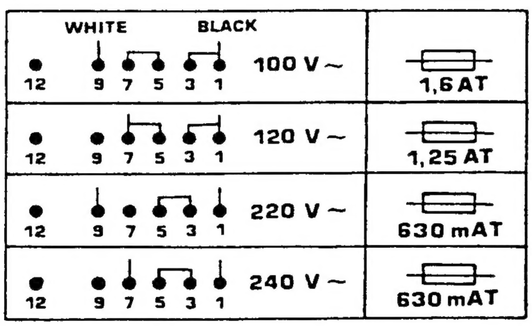
PM 5191: On delivery from the factory the instrument is set to 220 V – AC.
PM 5191 M (USA): On delivery from the factory the instrument is set to 120 V – AC.

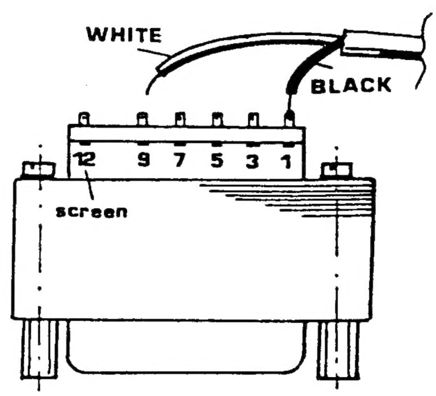
If the instrument is to be used on a different supply voltage the wiring must be altered; the main fuse should be replaced dependent on the mains voltage. The wiring for the fan must not be altered.

Proceed as follows:

- Loosen 2 cross-slotted screws at the rear side of the instrument (see also chapter 7.1.).
- Remove the top cover.
- Remove the isolating cover of the topside of the mains transformer, remove cable binder before.
- Alter the wiring of the mains transformer according to the connection diagram.
- Refit the isolating cover.
- If necessary, insert the advised fuse into the fuse holder instead of the fuse built-in. In this case change current label of the fuse holder.
- Change the mains voltage label at the rear of the instrument in accordance with the mains voltage selected.
  The labels for the mains voltage, current and the fuse are enclosed in a plastic bag.
- Close the instrument.

Connection diagram





3. OPERATING PRINCIPLE, Fig. 30 (Block diagram)

3.1. GENERAL OPERATING PRINCIPLE

The basic functional units, performing the generation, processing and conditioning of the generator output signals, are named

– DFS, Digital Frequency Synthesizer,	on unit 2
– MODULATOR	on unit 1
– PULSE GENERATOR	on unit 1
– AMPLIFIER	on unit 1

These functional units are under control of the CPU (Central Processing Unit), consisting of a microprocessor and its peripheral components on unit 2. Primary control data for the CPU is derived from the front-end KEYBOARD & DISPLAY on unit 3 or from an external controller via the IEEE/IEC bus interface. The output-signal parameters are displayed numerically on a 7-segment-LED display. Key LEDs are provided for operating mode indication. Subsequently a brief description of the over-all block diagram (fig. 30) of the generator is given.

3.2. DESCRIPTION OF THE BLOCK DIAGRAM

DFS

The primary signals – sine, triangular, positive and negative sawtooth waves – are generated by direct digital signal synthesis.

Binary samples of the wave are created in the SIGNAL SYNTHESIZER section and converted to analogue voltages by a fast DAC at the clock rate fc. The output frequency fo is directly related to fc, according to

$$fo = 0.1 \cdot N \cdot 2^{-33} \cdot fc = N \cdot 10^{-4}\ \text{Hz}$$

where N is the decimal equivalent of the binary frequency word, routed to the SIGNAL SYNTHESIZER from the CPU via U2-CONTROL BUS. fc is generated by an x-tal oscillator, the 8.59 MHz CLOCK. The AUTOMATIC SWITCH alternatively routes the external clock frequency to the SIGNAL SYNTHESIZER, if this is applied to the CLOCK INPUT. The DAC output signal is smoothed by the 3 MHz LPF, an anti-aliasing low-pass filter.

PULSE GENERATOR

The PULSE GENERATOR basically represents an electronical switching circuitry, creating a TTL signal and a square wave, each signal with a 50 % duty cycle. The instants of the positive and negative edges of these signals are determined by the zero-crossings of the DFS signal, e.g. a sine wave, fed to the ZERO CROSSING DETECTOR as reference.

Only if square wave at the generator output is programmed, the TTL output of the ZERO CROSSING DETECTOR is routed to the SQUARE WAVE CONDITIONER by the CONTROL CIRCUITRY. The TTL OUTPUT STAGE and the SQUARE WAVE CONDITIONER are creating the TTL output voltage of the generator and the primary square wave with accurate amplitude and waveform.

MODULATOR

By the VOLTAGE CONDITIONER the DFS sawtooth wave is halved in amplitude and shifted in dc, resulting in unipolar signals. The sine wave and the triangular wave are routed without change through the VOLTAGE CONDITIONER.

By the SELECTOR I either the output signal of the VOLTAGE CONDITIONER (sine, triangle, sawtooth) or the square wave of the PULSE GENERATOR is routed directly or through the AMPLITUDE MODULATOR to the AMPLIFIER.

In internal AM mode the modulating signal is derived from the MODULATION OSCILLATOR output. The modulating sine wave is fed to the AMPLITUDE MODULATOR through SELECTOR II. Alternatively – in the external modulation mode – the modulating signal is supplied from the generator MODULATION INPUT.

AMPLIFIER

The vernier setting of the generator output amplitude is performed by the AMPLITUDE CONTROLLER. After amplification by the POWER AMPLIFIER the signal either directly or after 20 dB respectively 40 dB attenuation by the STEP ATTENUATOR is routed to the OUTPUT socket. The DC GENERATOR adds the programmed dc voltage.

CPU

An 8-bit microprocessor (8031) and a 10 MHz clock are the constituents of the PROCESSOR & CLOCK. The PROGRAM MEMORY is a 8 Kbyte EPROM. In an external data memory, the 128 byte RAM, the storage register contents of the generator are stored. By the CONTROL BUS DRIVER the required load capability of the U1- and U2 CONTROL BUS serial data linie (SDA), and the clock line (SCL), is achieved. The device selecting strobe signals STR1 ... 15 – used for CPU components and latching-data-shift registers in the various functional units controlled by the CPU – are derived from 4 ports of the PROCESSOR by the STROBE DECODER.

The IEEE/IEC bus interface of the generator consists of the IEC BUS CONTROLLER, the DEVICE ADDRESS LATCH & SHIFT REGISTER and the 3-STATE GATE & LATCH.

4. PERFORMANCE CHECK

4.1. GENERAL INFORMATION

WARNING:
Before switching on, ensure that the instrument has been installed in accordance with the instructions outlined in Section 2 of the Operating Manual: Installation instructions.

This procedure is intended to:

- check the instrument
- be used for incoming inspection to determine the acceptability of newly-purchased instruments and/or recently-recalibrated instruments.

ATTENTION:
The procedure does not check every detail of the instrument's calibration; rather, it is concerned primarily with those parts of the instrument which are essential to measurement accuracy and correct operation. Removing the instrument covers is not necessary to perform this procedure. All checks are made from the front panel.

If this test is started within a short period after switching on, bear in mind that steps may be out of specification, due to insufficient warming-up time. To avoid this situation, allow the specified warming-up time of 30 min.

4.2. POWER-ON SELFTEST

Immediately after power on a selftest routine is started with which PROM and RAM are tested. If an error is detected one of the following error messages appears:

ERR 1	PROM	checksum error
ERR 2	RAM	(processor) checksum error
ERR 3	RAM	checksum error; operation possible but memory centents is destroyed.

In case of no error in PROMs/RAMs all LEDs and all segments of the displays are then switched on for appr. 3s after the software version has been indicated in the 'LEVEL'-sector of the display. The instrument must then be in the on-state which is indicated by a figure in the sectors of the display according with the last setting before switched off the LED 'Hz' or 'kHz' in the display and the LEDs in the keys according with the last setting.

4.3. GENERAL FUNCTIONAL TEST

The function of the synthesizer can now be checked with the help of the following examples:

amplitude = 5 Vpp; offset = 0 Vdc

terminate the output with 50 Ω and connect an oscilloscope.

Wave form	Frequency	Modulation	defective unit in case of faulty function
triangle	50 kHz	OFF	DFS
sine	2 MHz	INT depth 30 % Freq. 1 kHz	modulator
pos. sawtooth	500 Hz	OFF	DFS / CPU
square	2 MHz	OFF	pulse generator

If one of the functions doesn't work, the diagnostic program can be a help to distinguish whether the defect is in the unit in question or in the CPU with its C-bus drivers/decoders. By selecting TEST 4 (strobe test) it is possible to check the data communication lines and the decoders of the subunits.

In case that all functions are o. k. this test must be continued by checking the output signals:

TTL OUT: This output shows always a square wave voltage with TTL-level and signal-frequency.

INT CLOCK: This output contains the clock-signal of the internal digital frequency synthesizer with TTL-level and a frequency of 8.58993 MHz.

MODULATION: This output shows a sinewave signal with an amplitude of 0.3 Vrms

5. DIAGNOSTIC-PROGRAM PM 5191

This test program contains 5 submodules:

TEST 1: Display and LED test
TEST 2: Keyboard test
TEST 3: Storage register test
TEST 4: Strobe test (test of the internal interfaces)
TEST 5: Test for the IEEE/IEC-BUS interface

To activate this test program, press the key MODULATION OFF while power is switched on and keep it pressed for about 3 seconds.

The return to the main operating mode is only possible by switching power OFF and ON again.

When the test program is activated, the display shows "TEST x" where 'x' is a number from 1 to 5. This number changes continuously and slowly, and by pressing the key MODULATION OFF at the right moment, the respective test-submodule will be started.

To leave the test submodules, press the key MODULATION OFF for about 2 seconds.

TEST 1 : Display and LED test

Step 1: 7-segment-display

All display segments and LEDs are switched on for about 2 seconds.
After this the program starts to switch on one segment after the other for four display positions simultaneously. Finally, the decimal points of these four positions remain lit and the program starts to do the same with the next four display positions.
After the last four digits were tested, the program switches on all segments and LEDs and remain in this state until the key MODULATION OFF was pressed once again.

Step 2: LEDs

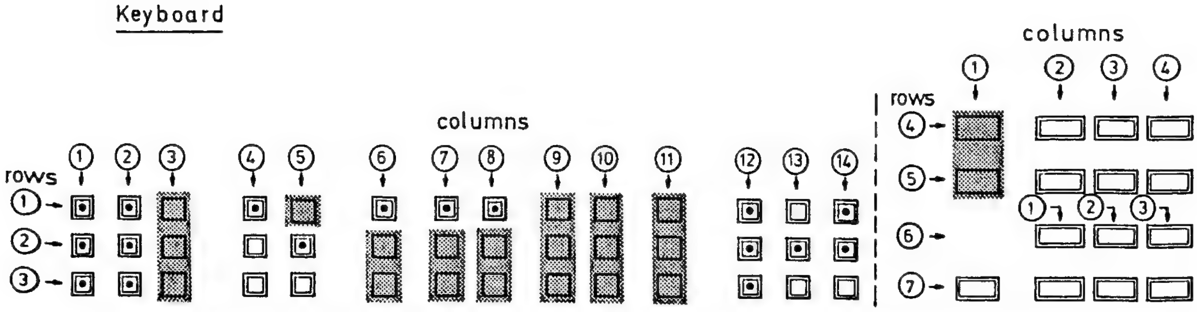
All LEDs will be switched on sequentially, one after the other, for approx. 0.5 seconds beginning with the uppermost left one (inside the key sine wave). When the last LED was switched on (key Δ LEVEL) it remains lit and the indication "End" appears at the display until the key MODULATION OFF was pressed. Then the program returns to the test-menu.

TEST 2: Keyboard test

The display shows the indication: 1 – Ø1 – – – –

Now you must press the first key of the first row: 1 – Ø1 – – – –
(row 1) – (column 1)

Keyboard



When the right key was pressed, the display shows

1 – Ø1   1 1 1 1

for about 1 second and changes then to

1 – Ø2   – – – –

as a request to press the second key in the first row. In case of a failure, the display would show

Err 1 – Ø1   x – xx

where x – xx indicates the wrong code (row and column). This error indication will only be reset by pressing the requested key – in case of a hardware failure at the keyboard unit it would not be possible to get the right code and thus to reset the error message.

When the last key was pressed, the keyboard test is finished and the display indicates "End". To leave this diagnostic submodule and to get back to the test menue, the key MODULATION OFF must be pressed.

TEST 3 : Storage register test

Attention:
This memory test damages the register contents. When the instrument is switched on after the storage register test was executed, the display indicates "Err 3" which means that there are now no parameters in the storage register – the complete contents (parameters) are destroyed.

The display indicates

MEMO 1 –

and the program starts to write a test pattern into each location of the memory chip, reads it again, and checks this value for correctness. When no failure was detected, the same will be done with a second pattern. In case that there is no failure, the display shows

MEMO 1 – 1

and in case of a failure

MEMO 1 – Ø

With MODULATION OFF the program returns to the test menu.

TEST 4 : Strobe test

The display indicates

STRO x

where x is a number from 6 to 15. This number changes continuously and slowly. By pressing the key "MODULATION OFF" at the right moment the required strobe line will be selected. The display shows then e.g.:

STRO Ø8 – 1

which means that the output lines of the shift registers controlled by strobe line 8 show a specific bit-pattern. If MODULATION OFF was pressed once for a short moment all output lines of the shift registers change their state. Now the display shows:

STRO Ø8 – Ø

Each time the MODULATION OFF-key is pressed for a short moment, the states of these output lines will be inverted. If MODULATION OFF is pressed for longer than about 1 second, this subprogram will be left and the display shows again:

STRO x

If the key MODULATION OFF is pressed again for longer than about 1 second, the program will return to the test menu.

This strobe test serves fault finding in the internal C-bus system. Measuring points, positions of ICs and measuring values are given in the following tables.

By strobe lines controlled ICs show the following bit patterns during STROBE-test:

Bit pattern ICs HEF 4094								
Pin no.	4	5	6	7	14	13	12	11
Strobe 'x' – Ø	Ø	1	Ø	1	Ø	1	Ø	1
Strobe 'x – 1	1	Ø	1	Ø	1	Ø	1	Ø

Association of these ICs:

Strobe line	Controlled ICs (Pos. no.)	Location	
Strobe 7	307, 308, 309, 310, 311	"DFS",	unit 2
Strobe 8	301, 302, 303	"Output Amplifier",	unit 1
Strobe 9	302	"Modulator",	unit 1
Strobe 11	301	"PLL",	unit 1
Strobe 15	311	"IEC-bus, function and address" CPU,	unit 2

Bit pattern IC HEF 40373								
Pin no.	2	5	6	9	12	15	16	19
Strobe 'x' – Ø	Ø	1	Ø	1	Ø	1	Ø	1
Strobe 'x' – 1	1	Ø	1	Ø	1	Ø	1	Ø

Association of this IC

Strobe line	Controlled IC (Pos. no.)	Location
Strobe 14	3Ø8	"IEC-bus out" CPU, unit 2

Strobe lines 6, 10, 12 and 13 are not used and have no control function.

TEST 5 : IEC-bus test

The display shows the indication

IEC BUS

Each character sent from the controller via the IEC (IEEE)-bus will be decoded and displayed with its hexadecimal code, e. g.

ASCII 'A' indication 41 H
ASCII '3' indication 33 H
etc.

The device address of the PM 5191 is fixed to 2Ø.

With the key MODULATION OFF the program returns to the test menu.

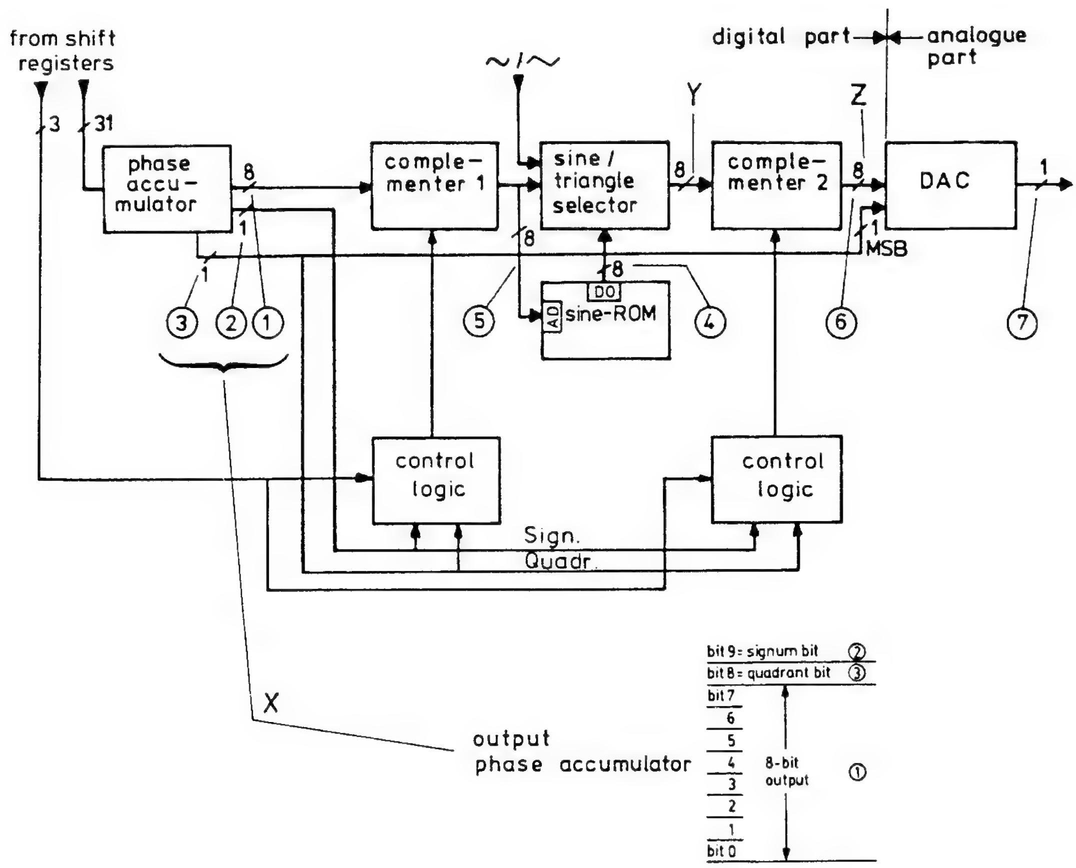
6. CIRCUIT DESCRIPTIONS

6.1. DIGITAL FREQUENCY SYNTHESIZER/U2

Signal Synthesizer

The primary signal of PM 5191 is generated in the digital frequency synthesizer (DFS). At the output of the digital section of the DFS the signal is presented as a sequence of 9-bit binary numbers. The digital samples of the signal are then converted to analogue voltages by means of a fast DAC.

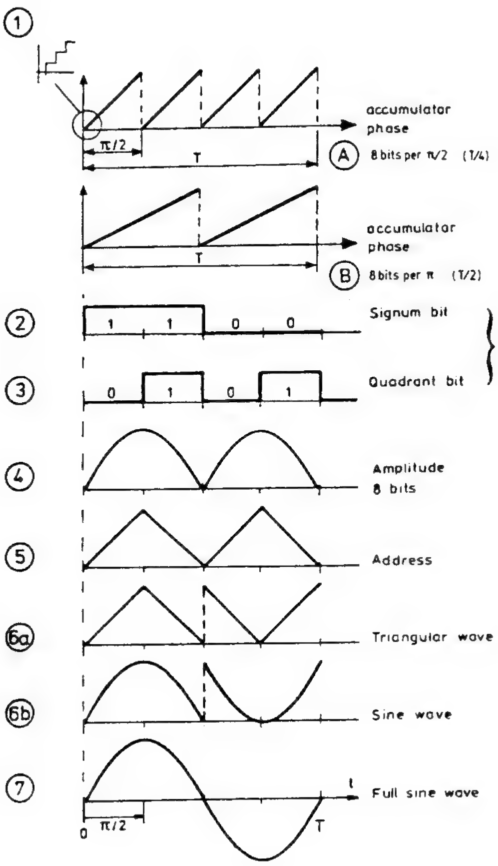
The frequency of the DFS is determined by a 40-bit frequency word which is sent from the CPU to the shift registers 307 — 311. The bit parallel shift register outputs are connected with the phase accumulator inputs. The phase accumulator is clocked by 8.5899 MHz from the clock generator. With each clock pulse the 9-bit phase accumulator output is incremented by the value of the frequency word. The resulting sequence of binary numbers represents a periodic sawtooth wave. By intermittant one's complementing (complementer 1) the signal is converted to a triangular wave. The samples of this signal are used as addresses for reading out a sine table ROM. The output is representing sine wave values for the first quarter period (4). By intermittant one's complementing in complementer 2 this signal is converted to a full sine wave (7).

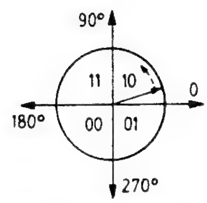


The phase accumulator is functionally divided into two parts. The upper part consists of the adders 312 — 319 and the D-registers 322 — 326 for the frequency range 1 mHz — 2.147 MHz. Frequency values for this range are sent in the 1 - 2 - 4 - 8 code. The lower part consists of the adders 320 and 321, the NOR gate 305 and the D-register 326 and covers the range 0.1 — 1 mHz. For this range the frequency values are applied in the Excess - 3 code which generates a 4-bit binary number with decimal value from 0 to 9 (carry at values > 9).

The upper part of the phase accumulator generates a sequence of 33 bit binary numbers from 0 to 2^{33} - 1. With each clock pulse the output is incremented by the value of the input frequency word. When reaching the upper limit the accumulator output resets and continuing incrementing starts again at zero. This results in a cyclic sequence of binary numbers which have a sawtooth wave form character. The frequency is $fg = 1/T = 0.1 \cdot N \cdot f_c \cdot 2^{-L}$ where N is the decimal value of the frequency word, f_c the clock frequency (8.5899 MHz $\approx 2^{33}$ mHz) and L the length of the 1 - 2 - 4 - 8 coded part of the phase accumulator (33 bits). The factor 0.1 results from the lower, excess-3-coded part which represents values of max. 10 (carry at values > 9).

The upper 10 bits of the phase accumulator are used for the subsequent signal processing. It is the actual accumulator output. The samples of the lower 8 bits of them represent a sawtooth wave with the period T/4 (1 A). The upper two of the 10-bit accumulator output (signum bit (2), quadrant bit (3)) determine the quadrant in which the vector of the DFS output signal (7) is actually located (3a). In complementer 1 (EXCLUSIVE-OR gates 331, 332) the 8-bit output is inverted during the second and fourth quarter period. The resulting signal (5) is fed to the sine/triangle selector (ICs 336, 337) and parallel to the address lines of the sine-ROM in which the sine wave values for the first quarter period (0 — $\pi/2$) are deposited.





3a resulting signal phase

For generating the wave form triangle the output of complementer 1 is fed directly to the sine/triangle selector by-passing the sine ROM. Thus the sawtooth signal (5) applied to complementer 2 results in the wave form (6a).

For sine wave the output data of the sine ROM (4) is picked up by the sine/triangle selector and routed to complementer 2 resulting in wave form (6b). By adding the signum bit (2) as the 9th bit, it results in wave form 7.

When generating positive or negative sawteeth the value of the binary frequency word at the phase accumulator input is halved – thus the sawtooth period at the phase accumulator output is doubled.

For positive going ramps control signal "a" is LOW. Therefore bits Ø – 7 are routed through complementer 1 without inversion to buffers 333 and 334. After passing sine triangle selector 336/337, the buffer 338/339 and complementer 2 without inversion ("b" = Ø) the signal is latched to the output by the D - FFs 342/343. The ninth bit at output 2/342 is directly derived from bit 8 of the phase accumulator through MUX 347 and the buffers 333 and 338 (= signal "c").

For negative going ramps one difference is that control signal "a" is HIGH. Therefore the signal (bit Ø – 7) is inverted by complementer 1. The second difference is that the ninth output bit (= "c") is inverted by EXCLUSIVE-OR gate 327 (pins 8, 9, 10) at input pin 2 of MUX 347.

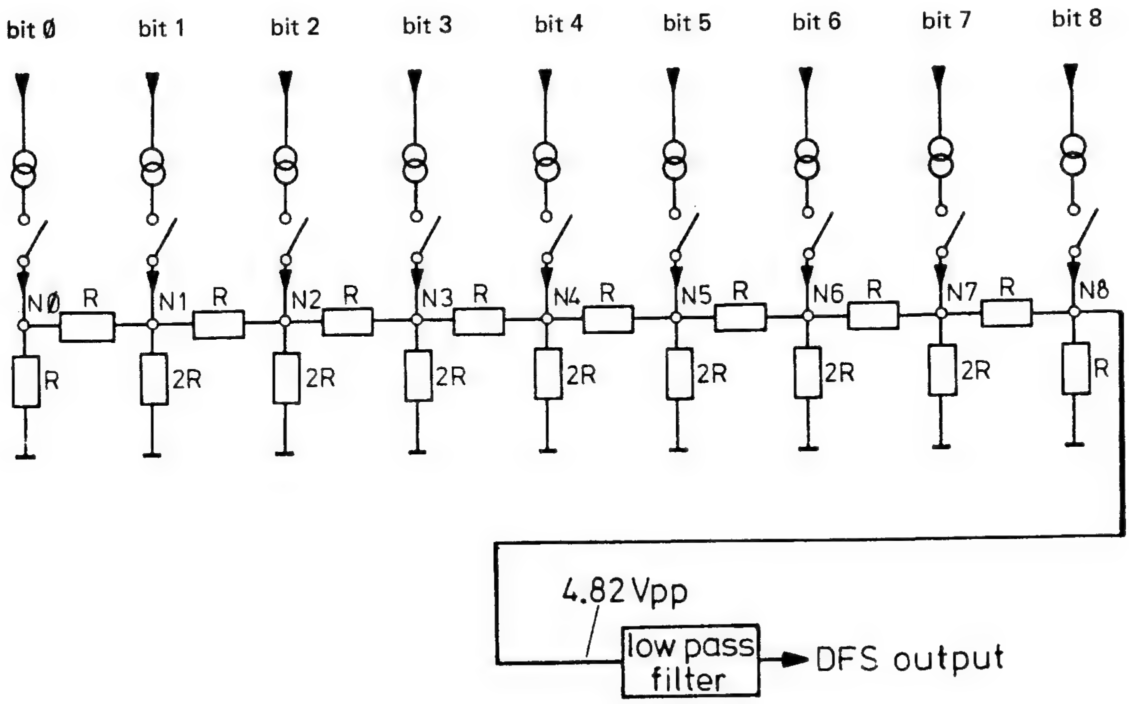
With LOW at the reset input the phase accumulator output can be set to zero. After reset is switched back to HIGH, the signal generation startes again in the way as described before.

DAC

The binary signal coming from complementer 2 via buffers 342, 343 is converted to an analog voltage in the DAC (see fig. below and fig. 37).

At the DAC inputs the drivers 344, 345 are located which are controlling the current switching differential transistor stages 403 - 404, 406 - 407 . . . 427 - 428. The DC-currents (each 5.85 mA = $I_Ø$) are generated by individual circuits. The MSB (bit 8) - current source for instance includes transistor 427 and one OP of IC 346. The bit 7 - current source includes transistor 424 and the other OP of IC 346. The remaining current sources use also this second OP of IC 346. The individual currents – if switched on – are routed to the corresponding nodes NØ – N8 of the R – 2R ladder shown below. The input impedance of each node is 2R/3, with R = 619 Ω (2R/3 = 412.67 Ω). Therefore each current – if switched on – is building up the same voltage at the corresponding node ($I_Ø$ * 2R/3 = 2.41 V). The transformation to the output depends on the node position in the ladder. Generally from node n to node n+1 the voltage is divided by two. Thus for instance the voltage at node N3 (bit 3) is transformed to the output node N8 by the factor $2^{-(8-3)}$ = 1/32. The output voltage of the ladder at node N8 is filtered by the anti alias low pass filter 803, 804, 559 – 562. This filter with a passband of about 3 MHz suppresses especially the spectral contents at both sides of the clock frequency (8.5899 MHz). The output signal is buffered by the transistors 430, 431.

For deglitching purposes of the DAC the current switching point of bit 8 can slightly be shifted with the trimpot 689 versus the current switching points of bits Ø – 7. The latter switching points are set with trimpot 676. By an iterative calibration procedure with both these trimpots the sine wave distortion gets minimized.



6.2. MODULATOR / U1

By the VOLTAGE CONDITIONER (IC 301 and additional components) the positive and negative DFS sawtooth wave are halved in amplitude and shifted in dc, resulting in unipolar signals. The sine wave or the triangular wave is routed through the VOLTAGE CONDITIONER without modification. By the SELECTOR I (relais 810, 811) either the output signal of the VOLTAGE CONDITIONER (sine, triangle, sawtooth) or the square wave of the PULSE GENERATOR (conditioned by transistors 359 and 361) is routed directly or through the AMPLITUDE MODULATOR via relay contacts (813 – 815) to the AMPLIFIER unit.

In internal AM mode the modulation signal is derived from the MODULATION OSCILLATOR (IC 304 and additional components), a 'Wien-bridge' oscillator. The modulation signal, a sine wave of constant frequency (1 kHz) and amplitude (0.3 Vrms), is fed to the AMPLITUDE MODULATOR through SELECTOR II (IC 303). Alternatively, in external modulation mode, the modulation signal is supplied from an external source via the input socket MODULATION.

The AMPLITUDE MODULATOR (IC 305), an analogue four-quadrant multiplier, multiplies the VOLTAGE CONDITIONER output signal or the square wave by the internal or external modulation signal. The modulated signal is fed to the AMPLIFIER unit.

The VOLTAGE CONDITIONER and the AMPLITUDE MODULATOR are controlled by the CPU via shift register (302).

6.3. PULSE GENERATOR / U1

1. Square wave generation

According to fig. 30 (over-all block diagram) and fig. 43 (circuit diagram) the section of the PULSE GENERATOR, which generates the primary square wave, fed to the AMPLIFIER, comprises the following subsections:
- ZERO CROSSING DETECTOR, IC 301,
- CONTROL CIRCUITRY, IC 305, Transistor 351,
- SQUARE WAVE CONDITIONER, Transistors 352 . . . 355.

Zero crossing detector

By resistors 602, 605, 606 a slight hysteresis is implemented for accurate transitions without glitches at the zero crossings of the DFS input signal.

The ZERO CROSSING DETECTOR output signal is ANDed with the $\overline{\text{PULSE SELECT}}$ from transistor 351. Only if square wave is programmed the SQUARE WAVE CONDITIONER will be active. The input signal for the TTL OUTPUT-STAGE is not affected by the $\overline{\text{PULSE SELECT}}$ signal and routed directly from the ZERO CROSSING DETECTOR to the TTL OUTPUT-STAGE.

The SQUARE WAVE CONDITIONER converts the TTL signal of IC 305 / pin 6 to a square wave, accurate in shape and amplitude (about 2.4 Vpp). Trimpots 624 and 627 are adjusted for accurate positive and negative amplitudes at the generator output.

2. TTL output voltage generation

The output voltage of IC 305 / pin 8 is fed to the TTL OUTPUT STAGE with the transistors 356 . . . 358. The TTL OUTPUT is present in all waveform modes and not inhibited by IC 305.

6.4. AMPLIFIER / U 1

As depicted in the over-all block diagram fig. 30, the AMPLIFIER includes the sub-sections
- AMPLITUDE CONTROLLER
- POWER AMPLIFIER
- STEP ATTENUATOR
- DC GENERATOR

1. AMPLITUDE CONTROLLER

As depicted in the figure below, the input amplitude pp of the AMPLITUDE CONTROLLER is fixed to V_i = 1.90 V for sine, triangle and square waves or 0.95 V for sawtooth waves. The output amplitude V_A is related to V_i corresponding to

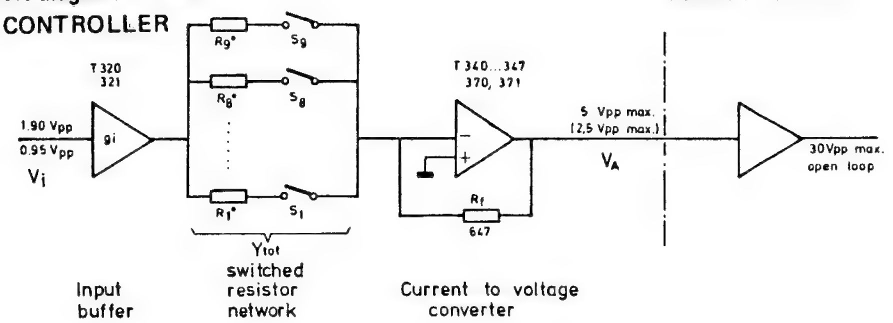
$$\frac{V_A}{V_i} = g_i \cdot Y_{tot} \cdot R_f$$

In the simplified circuit diagram Y_{tot} depends on those resistors of the switched resistor network which are connected to the virtual ground of the current to voltage converter input. The resistors $R_1, \ldots, R_9$ are in accordance with $1/Y, 2/Y, 4/Y, \ldots, 128/Y, 45/Y$, where $1/Y = 525\ k\Omega$.
Thus

$$\frac{V_A}{V_i} = g_i \cdot N \cdot Y \cdot R_f \approx 0.0087 \cdot N$$

N is an integer between 0 and 300 determined by the positions of the switches $S_1, \ldots, S_9$. The related weights of the switches are 1, 2, 4, . . ., 128 for S_1 to S_8 and 45 for S_9.

simplified circuit diagram of the AMPLITUDE CONTROLLER



Example: N = 100

In this case switches S_3, S_4, and S_5 are closed. Thus N = 4 + 32 + 64 = 100 and V_A/V_i = 0.87, or V_A = 1.7 (0.85) Vresp. In the real circuitry R_1^* to R_4^* are not discrete serial resistors but presented by resistor T-sections. E. g.

$$R_1^* = \frac{1}{Y} = R_{611} + \frac{R_{620}\,(R_{611} + R_{624})}{R_{624}}$$

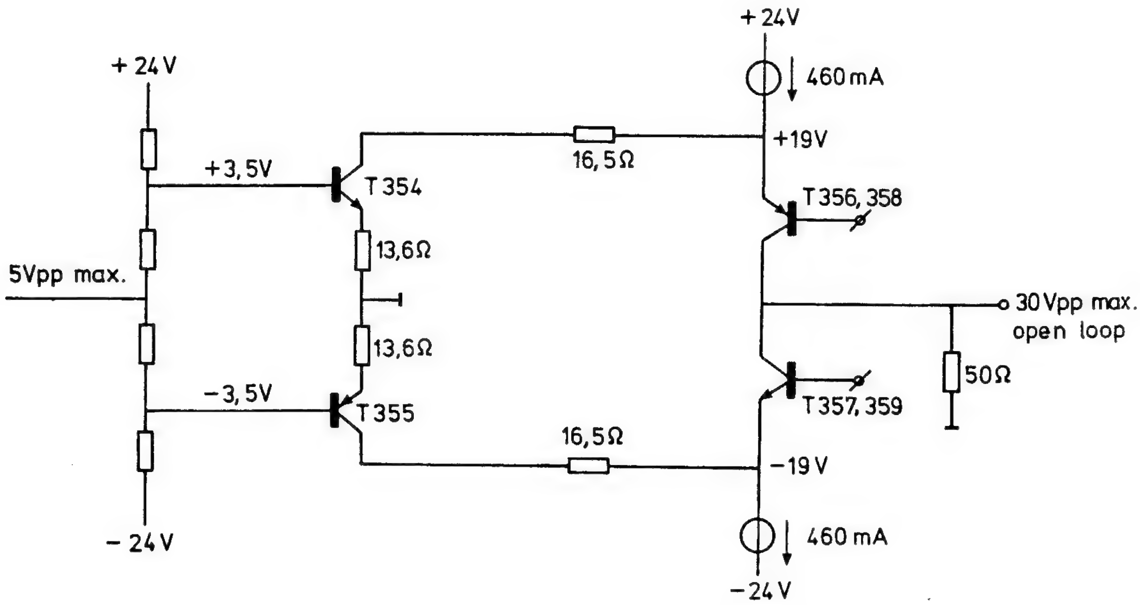
The serial switches $S_1, \ldots, S_9$ are realized by the FETs 329, 325, . . ., 339. The FETs 322, 324, . . ., 338 are adapted for constant load of the input buffer, independently of the programmed amplitude. They are switched on/off inversely to 323, 325 . . . 339. In the switch-off state the gates of the serial FETs are biased to about – 10 V by the resistors of the arrays R764 . . . 767.

The collector-output currents of the current to voltage converter differential input stage (T340 . . . 343) are routed directly respectively via current mirror (T370, 371) to the emitters of the common-base stages T344 and T345. By the emitter-follower T346, 347 the collector-output voltage of T344, 345 is buffered.

2. POWER AMPLIFIER

The AMPLITUDE CONTROLLER output is split by the POWER AMPLIFIER input buffer (T348 – 353) into two pathes with opposite dc voltages, and supplied to the common-emitter stage (T354, 355). The output currents are fed to the emitters of the common-base stage (T356, 357). The collector output currents are routed to the inner 50 Ω resistor, made up by the resistors 721 – 732.

simplified circuit diagram
of the POWER AMPLIFIER



Some DC-potentials of the AMPLITUDE CONTROLLER and POWER AMPLIFIER section

AMPLITUDE CONTROLLER		POWER AMPLIFIER	
measuring point	measuring value (Vdc)	measuring point	measuring value (Vdc)
base of T370/371	8	base of T348/349	~ 0
base of T344	4	base of T350	– 0.7
base of T346	~0	base of T352	2.9
		base of T354	3.5
		emitter of T354	2.9
		base of T372	21.5
		collector of T372	19
		emitter of T372	22
		base of 358	17.6
		base of 360	18.2

(all voltages measured to ground)

3. STEP ATTENUATOR

The STEP ATTENUATOR includes two resistor pi-sections, each symmetrically matched to 50 Ω. Switching is performed by 'Reed-contact relais' controlled by shift register 303 through drivers 311.

Function table of STEP ATTENUATOR switches

att. \ switch	K1, K3	K2, K4	K5, K7	K6, K8
0 dB	x	o	x	o
20 dB	x	o	o	x
40 dB	o	x	o	x

x : closed   o : open

4. DC GENERATOR

Primary control of the DC GENERATOR is performed by the DAC (IC 307). The DAC is set by shift register 302 to output currents I_0 at pin 4 from 0 to about $\frac{200}{255} \cdot I_{ref} = 0.55$ mA proportional to the decimal equivalent 0 – 200 of the binary shift register output ($I_{ref} \approx 0.71$ mA, current into pin 14 of IC 307). If the decimal equivalent is 100, i. e. DC $\triangleq$ 0 V, I_0 is compensated by the constant current $I_c \approx \frac{0.55}{2}$ mA via resistors 697, 698. Hence, in this situation no current is drawn from the input (pin 6 of IC 308) of the dc generating circuitry ($I_1 = I_2 = 0$).

For positive output current I_{out}, i. e. positive dc voltage at the generator output, the following conditions are valid:

shift register output $>$ 100 (decimal)

$$I_0 > I_c \Rightarrow I_1 > 0 \; ; \; I_2 = 0$$

The upper section (transistor 362, IC 309 etc.) of the circuitry is translating I_1 to I_{out} according to:

$$I_{out} = (I_0 - I_c) \cdot A_1 \cdot A_2$$

wherein

$$A_1 = \frac{I_4}{I_1} \quad \text{and} \quad A_2 = \frac{I_{out}}{I_4}$$

are the current gain factors of the transistor 362 stage and the IC 309 current translator stage respectively. These gains are

$$A_1 \approx \frac{R699}{R702} + 1 \approx 17{,}96 \quad ; \quad A_2 \approx \frac{R701}{R711-713} \approx 41{,}35$$

For negative output current I_{out}, i. e. negative dc output voltage, the following conditions are valid:

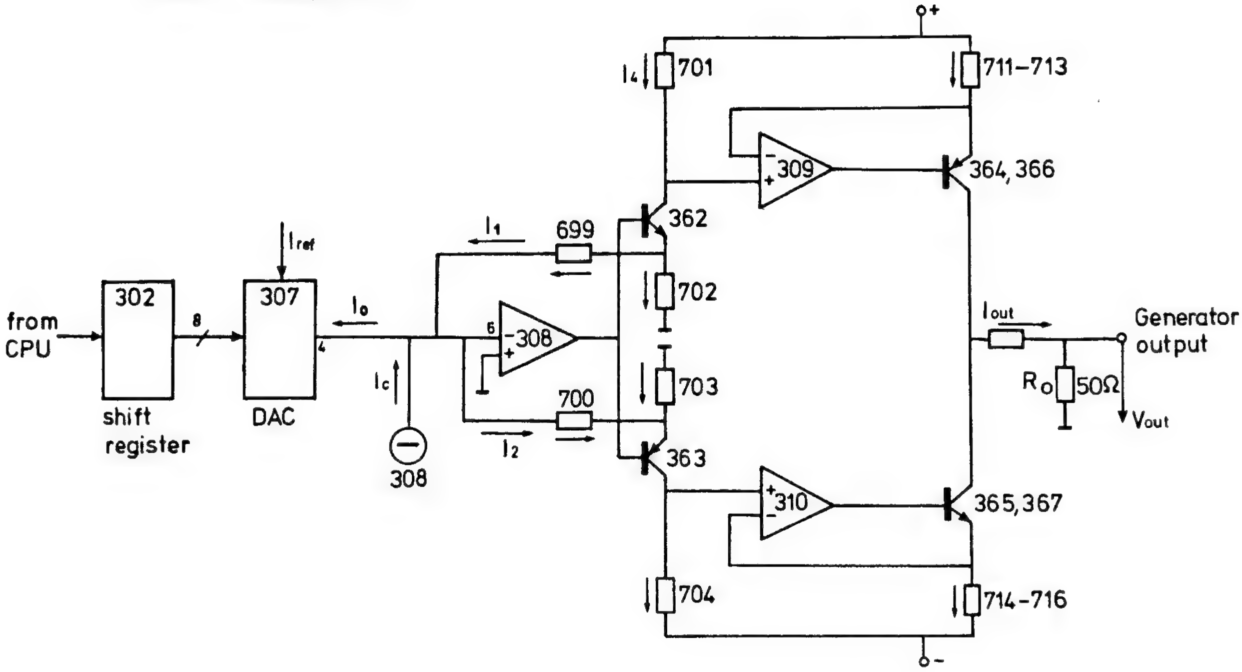
shift register output $<$ 100 (decimal)

$$I_0 < I_c \Rightarrow I_1 = 0 \; ; \; I_2 > 0$$

The lower section (transistor 363, IC 310 etc.) of the circuitry is translating I_2 to I_{out}.

The generator output voltage V_{out} is given as the voltage drop by I_{out} at the amplifier output resistance Ro (721 – 732).

simplified circuit diagram
of the DC GENERATOR



The schedule shows current and voltage values of the DC GENERATOR in dependence on the shift register output.

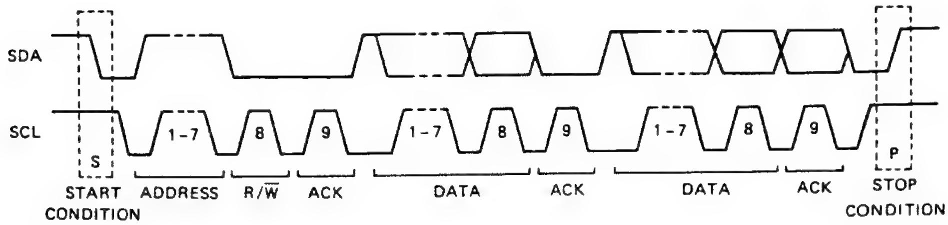
shift reg. output pos. 302 (decimal)	I_c (mA)	I_0 (mA)	I_1 (mA)	U_{702} (V)	U_{701} (V)	$U_{711-713}$ (V)	I_2 (mA)	U_{703} (V)	U_{704} (V)	$U_{714-716}$ (V)	I_{out} (mA)	Gen. output volt. (V)
0	0.27	0	0	0	0	0	0.27	2.9	3.1	3.1	–200	–10
50	0.27	0.14	0	0	0	0	0.14	1.5	1.6	1.6	–100	–5
100	0.27	0.27	0	0	0	0	0	0	0	0	0	0
150	0.27	0.41	0.14	1.5	1.6	1.6	0	0	0	0	+ 100	+ 5
200	0.27	0.54	0.27	2.9	3.1	3.1	0	0	0	0	+ 200	+ 10

6.5. CPU / U2

The CPU of the PM 5191 contains the μ-processor 8031 with all drivers, decoders, RAM- and PROM memory, clock generator, IEC-bus interface and the strobe-decoder.

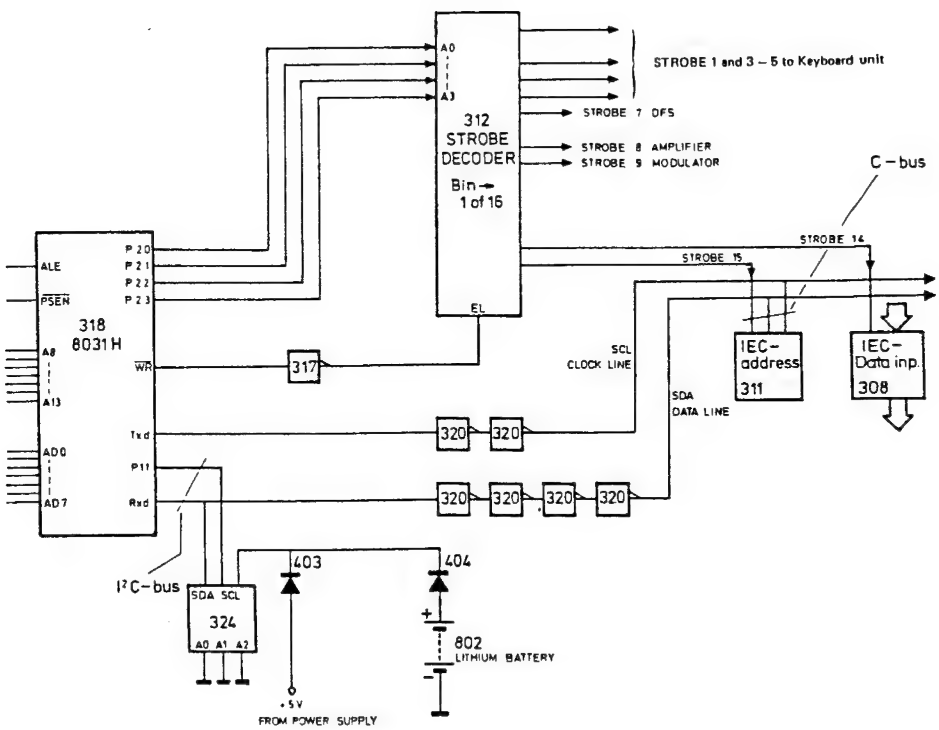
The multiplexed address/data bus (ADØ – AD7) of the processor 318 supplies the address inputs AØ – A7 of the PROM-memory 315 via the address latch 314 (74LS363), the inputs A8 – A13 are supplied directly from the processor (P20 – P25). Data from the PROM is fed from the outputs OØ – O7 via the lines ADØ – AD7 directly to the processor, this transfer is controlled with the output PSEN (program store enable) from the processor driving the input OE of the PROM.

The memory circuit 324 serves the storing of the actual parameter set. Communication with them takes place via the internal serial I^2C bus which consists of a data line SDA and a clock line SCL. The principle of the data transfer between processor and the RAM-memory is shown in the following diagram.

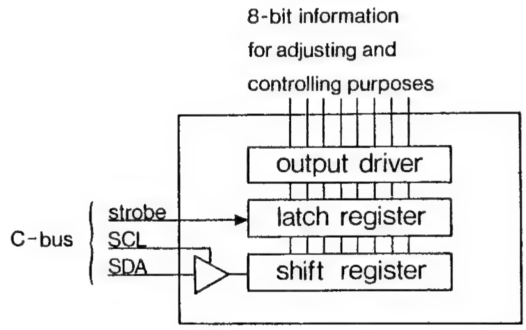


The two lines SDA and SCL of the C-bus serve the communication with the remaining units. The data information of the line SDA is clocked into the shift register of each unit, the according strobe signal following this data sequence latches the data information in the selected shift register and presents the transmitted information in parallel form at the output lines of this circuit. The required strobe signals are generated with the strobe-decoder 312 which is controlled again from the processor via the lines P20 – P23 and the signal $\overline{WR}$.

Internal communication via I^2C- and C-bus

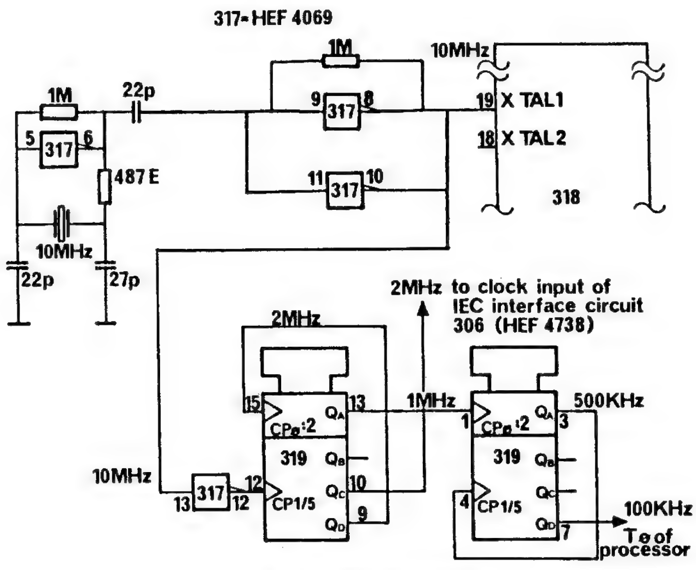


Converting the serial information to a parallel one the parallel output presents the decoded commands.



conversion from serial to parallel information

The clock signals for processor and IEC controller as well as a 100 kHz signal for the internal timer are generated in the 'clock generator' circuitry. This part of the CPU consists of the crystal 801, the inverter 317 and the decimal counter 319. The 10 MHz clock from the inverting buffer is fed to input XTAL 1 of the processor, furthermore divided by 5 with the decimal counter 319 and then fed to the IEC-controller 306. After further dividing by 20 the output 7 of the counter deliveres the 100 kHz signal TØ for the timer.

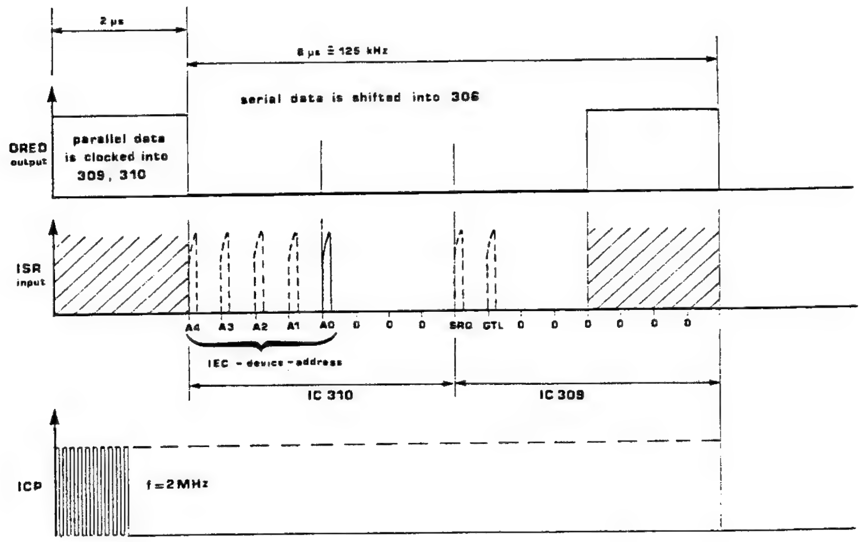


IC 319=Decimal counter

clock generation

Remote control of the PM 5191 follows via the IEC-interface which consists of the controller 306, the bus drivers 301 – 304, the buffers 307, 308 and the shift registers 309 – 311. Input data (control commands) from the IEC-bus connector are fed to the data bus ADØ – AD7 via the bidirectional bus drivers 303 and 304 and buffer 307. Output data (learn- and identification mode) are accordingly fed to the IEC-bus via buffer 308 and the bus drivers 303 and 304. Data direction and enable of the buffers are controlled by the IEC-bus controller 306 via the output Ota (other talk address) and by the processor with the signal 'strobe 14'.

The listener/talker addresses and the interface parameters necessary for the communication are sent to the IEC-controller in serial form. The microprocessor sends these informations via the C-bus with the help of the signal STR 15 to the shift register 311. The parallel outputs of this circuit supply again the parallel inputs of the shift registers 309 and 310 by means of which addresses and interface parameters are transferred to input ISR (input shift register) of the IEC-bus controller. This transfer action is controlled from the controller circuit, the repetition rate is 125 kHz (= 2 MHz/16).

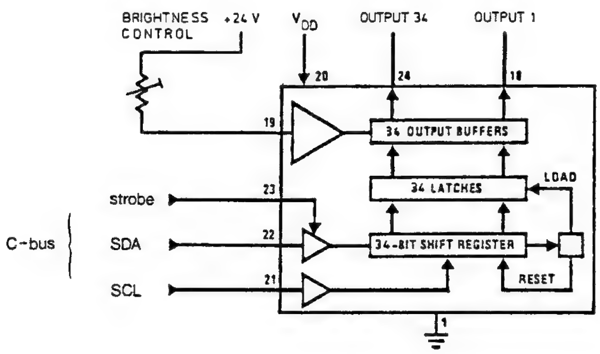


Each data string for the shift registers 309 and 310 contains the IEC device-address and one bit for SRQ on or off. The data string entered from the IEC controller 306 via input 'ISR' has a length of 11 bits, not required bits at the inputs of ICs 309/310 are fixed to ground. Input GTL of these circuits – pin 15 of IC 309 – is controlled directly from the key LOCAL at the front panel. Pressing this key causes the IEC controller 306 to switch back to the local mode.

6.6. KEYBOARD DISPLAY UNIT / U3

Unit 3 of the synthesizer PM 5191 contains LEDs keys and display elements with their concerning driver/decoder circuits. Data transfer from the CPU to the keyboard/display unit takes place via the C-bus (SDA, SCL, Strobe 1, 3 – 5), input data from the keyboard are sent as a sequence of 12 pulses from the keyboard encoder 353 via the line SKC to the CPU. The key 'LOCAL' is directly led to the IEEE/IEC interface on unit 2 via line GTL.

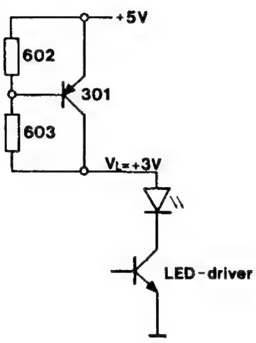
Display data are sent in 34 bit data blocks via the C-bus to the according part of the display unit, selection (= addressing) of this part is done with one of the strobe signals STROBE 1 or STROBE 3 – 5. During the data transfer from the CPU to the keyboard/display unit the according strobe line is set and a data block is loaded into the shift register with the clock signal SCL. The last bit at the data input shifts the complete data set into the latch register and therewith to the display elements/LEDs via the buffer stage.



Each of the five strobe lines controls the data transfer to one of the display groups:

STROBE 1 display circuit 408 for	amplitude, Vdc, address and the LEDs in the keys 'Vrms' and 'ADDRESS'
STROBE 2 not used	
STROBE 3 display circuit 406 for	frequency display (right part) and the LED in the key 'FREQ'
STROBE 4 display circuit 405 for	frequency display (left part)
STROBE 5 LED driver circuit 352	

Voltage supply for the LEDs and displays comes from the + 5 V which is reduced to + 3 V (VL) by means of the transistor 301 and the resistors 602 and 603

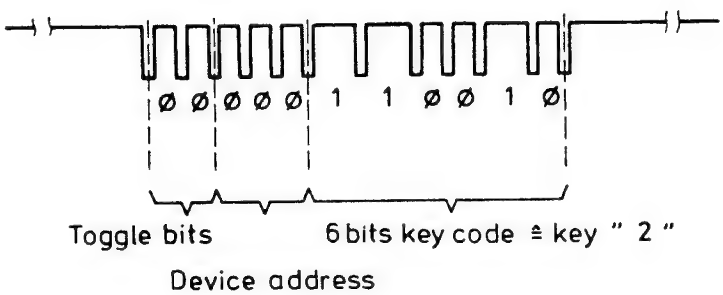


the transistor 301 is placed behind the front plate at a spacing piece beside the socket TTL OUT.

Brightness of the LEDs/displays is adjusted with a reference voltage at the inputs BC (brightness control) of the driver circuits. These reference voltages are derived from the + 24 V supply by means of the resistors 604 – 608 feeding currents into the BC-inputs.

Input from the keyboard takes place with the help of the keyboard encoder IC 353 (SAA 3007) which controls the 8 x 8 keyboard matrix and sends the keycode in serial form from the output REMO via line SKC to the CPU. During the rest condition the sense lines SENØ – SEN6 are 'high', the drive lines of the matrix DRVØ – DRV6 are 'low', the last drive line is fixed to ground.

When a key is pressed the according sense line is forced to 'low', the internal logic of the encoder starts the scan of the matrix and transmits a sequence of 12 pulses whereby the distance between two pulses means binary "Ø" or "1".



Each time a key is pressed such a bit sequence must be measurable at line SKC (pin 10 of the CIS connector). The toggle bits of this message are incremented by 1 each time when a key is pressed. Thus it is possible to distinguish between a key being pressed several times or once for a longer time.

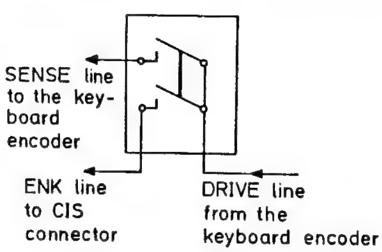
The device address is fixed to "ØØØ" and the last 6 bits show the following pattern by pressing the corresponding key

Key	Connection between	Key code
∿	DRVØ – SENØ	ØØØØØØ
⊿	DRVØ – SEN1	ØØ1ØØØ
◺	DRVØ – SEN2	Ø1ØØØØ
∧∨	DRV1 – SENØ	ØØØØØ1
⊓⊔	DRV1 – SEN1	ØØ1ØØ1
AC OFF	DRV1 – SEN2	Ø1ØØØ1
FREQ	DRV3 – SENØ	ØØØØ11
Hz/kHz	DRV3 – SEN1	ØØ1Ø11
–STEP	DRV3 – SEN2	Ø1ØØ11
ΔFREQ	DRV4 – SEN1	ØØ11ØØ
+STEP	DRV4 – SEN2	Ø1Ø1ØØ
OFF	DRV5 – SENØ	ØØØ1Ø1
EXT	DRV6 – SENØ	ØØØ11Ø
INT	⊥ – SENØ	ØØØ111

Key	Connection between	Key code
Vdc	DRV3 – SEN3	Ø11Ø11
Vpp	DRV3 – SEN4	1ØØØ11
ΔLEVEL	DRV3 – SEN5	1Ø1Ø11
+/–	DRV4 – SEN3	Ø111ØØ
dBm	DRV4 – SEN4	1ØØ1ØØ
–STEP	DRV4 – SEN5	1Ø11ØØ
ADDRESS	DRV5 – SEN3	Ø111Ø1
Vrms	DRV5 – SEN4	1ØØ1Ø1
+STEP	DRV5 – SEN5	1Ø11Ø1
RUB OUT	DRV4 – SEN7	1111ØØ
Ø	DRVØ – SEN6	11ØØØØ
1	DRV1 – SEN6	11ØØØ1
2	DRV2 – SEN6	11ØØ1Ø
3	DRV3 – SEN6	11ØØ11
4	DRV4 – SEN6	11Ø1ØØ
5	DRV5 – SEN6	11Ø1Ø1
6	DRV6 – SEN6	11Ø11Ø
7	⊥ – SEN6	11Ø111
8	DRVØ – SEN7	111ØØØ
9	DRV1 – SEN7	111ØØ1
"●"	DRV2 – SEN7	111Ø1Ø
ENTER	DRV3 – SEN7	111Ø11

The clock for the keyboard encoder is generated with the ceramic resonator 860. During the rest condition – i. e. no key is pressed – there is no signal at input 11 or 12 of the keyboard encoder. When any key – except LOCAL – is pressed, the clock supply will be activated and a signal with a frequency of 455 kHz and an amplitude of 4,5 Vpp can be measured at pin 11 or 12. By pressing a key only once for a short moment the clock will be switched on for approx. 170 ms., pressing a key for longer will keep the clock supply switched on as long as the key is pressed.

The key MOD OFF contains one more switch contact which is commonly connected to line ENK (enable keyboard), to start the diagnostic program (see chapt. 5) during switching on of the instrument.



7. ACCESS TO PARTS

7.1. TOP AND BOTTOM COVERS (DISMANTLING THE INSTRUMENT)

Before opening the instrument unplug mains connector, take note of chapter 1.5..

- Loosen the cross-slotted screws Ⓐ (Fig. 7-1) at the rear
- Pull top cover Ⓑ as shown in figure 7-1.
- The procedure to remove the bottom cover Ⓒ is the same as above.

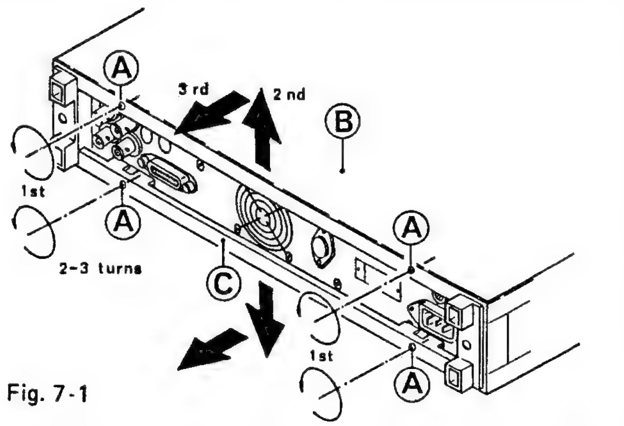


Fig. 7-1

7.2. FUSE, MAINS TRANSFORMER

For mains voltage setting and fuses and the assigned safety instructions see chapter 2.

7.3. UNIT 1 AND UNIT 2

For access to the upper side of unit 2 and the bottom side of unit 1 it is only necessary to remove the top cover respectively the bottom cover of the instrument (see chapter 7.1.).

To reach the upper side of unit 1 and the bottom side of unit 2 proceed as follows:

- Unplug the connector Ⓖ (Fig. 7-5) on the right hand side of unit 2.
- Remove 2 screws Ⓐ (Fig. 7-5) at the sides of the instrument.
- Lift the pcb as arrow Ⓒ shows in Fig. 7-5. (If it is heavy to move the pcb, loosen the screws at the pivot a little bit.).
- Fixing unit 2 in an upright position insert screw Ⓐ in position Ⓗ (Fig. 7-5).
- The other steps shown in fig. 7-5 are not necessary to reach unit 1 + 2.

7.4. FRONT-PANEL EDGING

- Remove covers (chapt. 7.1.).
- Lift the profile ornament Ⓐ (Fig. 7-2) with a small screw driver.
- Remove the screws Ⓑ (Fig. 7-2).
- Remove the edging Ⓒ (Fig. 7-2).
- For the bottom side the same procedure applies.

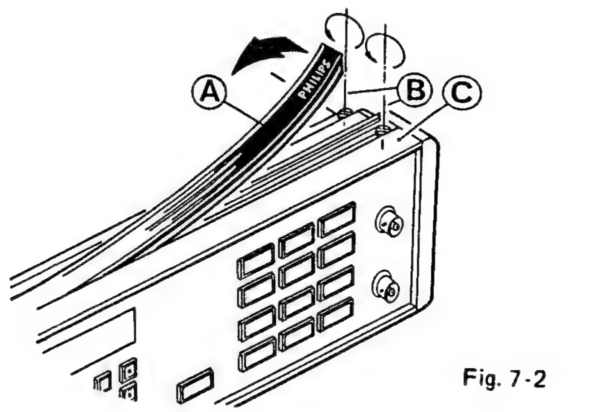


Fig. 7-2

– Remove screws Ⓑ (Fig. 7-3)

– Remove side pieces Ⓐ (Fig. 7-3)

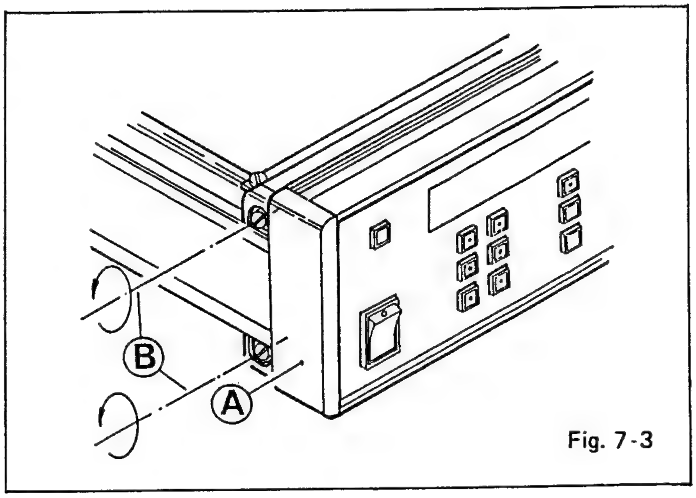


Fig. 7-3

7.5. TEXT PLATE

The text plate Ⓐ (Fig. 7-4) is fixed by three parts of doublesided adhesive tape Ⓑ (Fig. 7-4)

– To remove the text plate insert carefully a screwdriver near the tapes and move the screwdriver as shown in Fig. 7-4.

– Steps described in chapters 7.1 and 7.4. are necessary before.

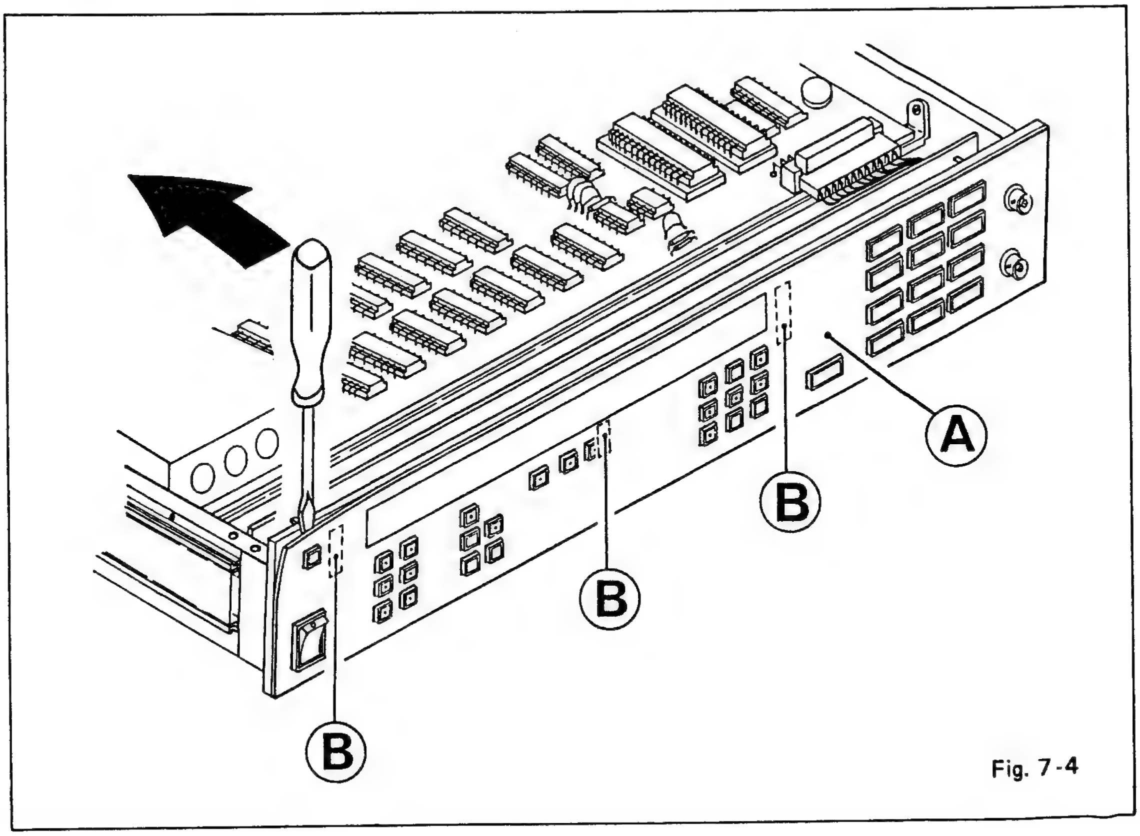


Fig. 7-4

7.6. UNIT 3 (KEYBOARD AND DISPLAY)

At first steps described in chapters 7.1., 7.4. and 7.5. must be done

- Unplug connector Ⓖ (Fig. 7-5)
- Loosen all screws Ⓕ (Fig. 7-5) at the front of the instrument
- Pull carefully frontplate Ⓔ (Fig. 7-5) forwards, take care of the wires of the BNC-connectors and the main switch
- Remove unit 3 Ⓓ (Fig. 7-5)
- The other steps shown in this figure are not necessary to reach unit 3.

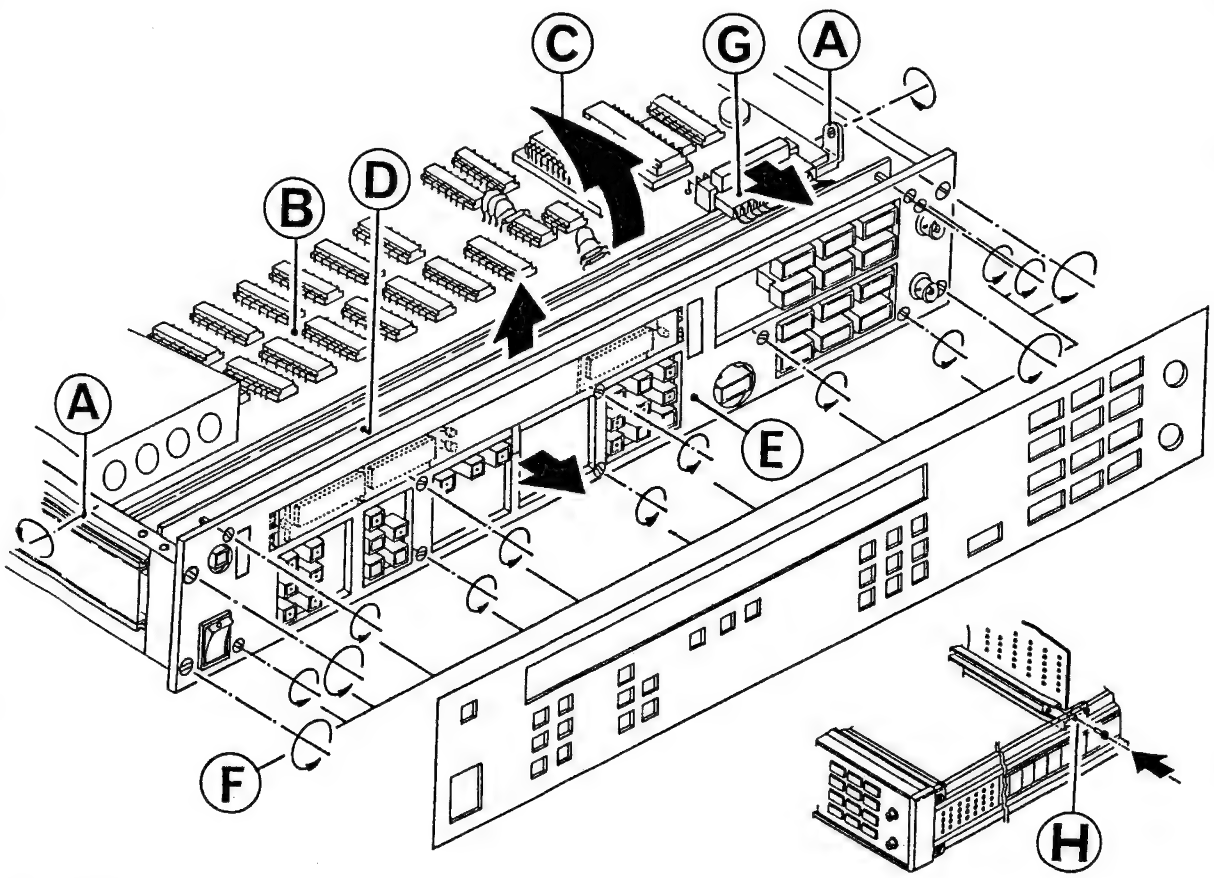


Fig. 7-5

7.7. CARRYING HANDLE

- Lift the carrying handle.
- Prise off carefully both plastic profile strips next to the handle in the similar way as the profile ornament of the front-panel edging shown in Figure 7-2.
- Loosen cross-slotted screws of the holder for handle.

7.8. HANDLE ASSEMBLY FOR RACK MOUNTING

- Remove top and bottom covers as described in chapter 7.1.
- Looser screws Ⓑ (Fig. 7-6).
- Remove side piece Ⓒ .
- Fit handle Ⓐ , refit screws Ⓑ
- For the right hand side the same procedure applies.
- Close the instrument

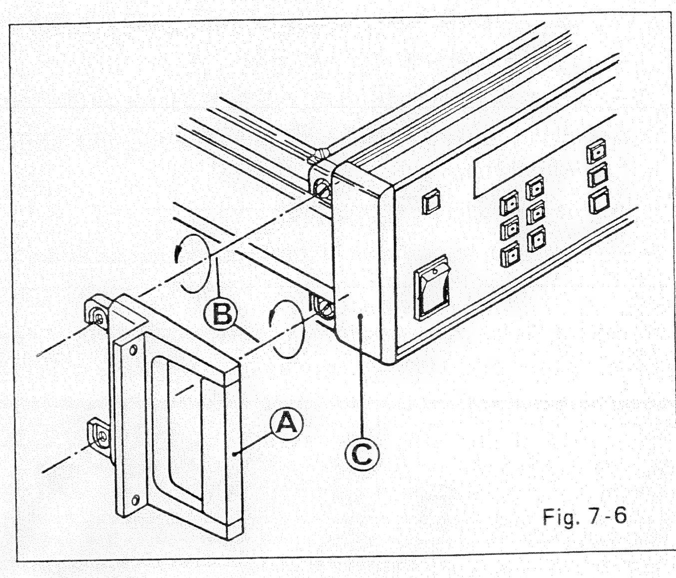
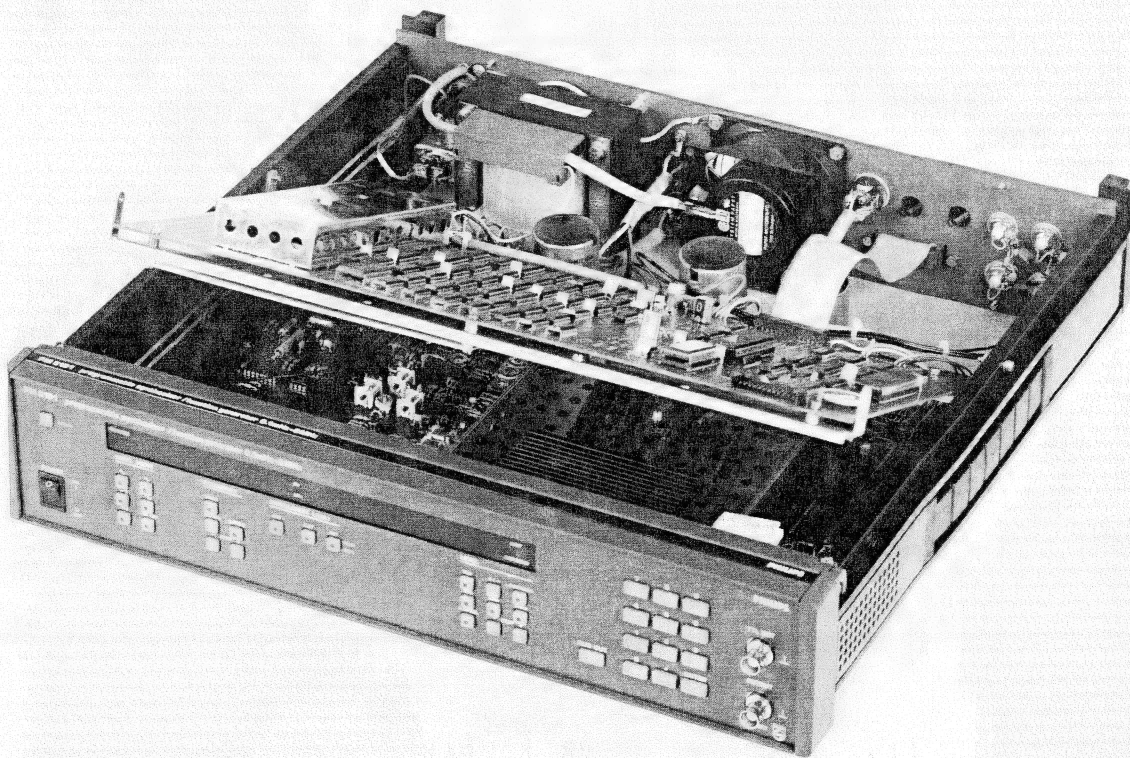


Fig. 7-6

7.9. VIEW INTO THE OPEN INSTRUMENT



PM 5191 without top cover

8. CHECKING AND ADJUSTING

8.1. GENERAL INFORMATION

The following information provides the complete check and adjustment procedure for the instrument. As various control functions are interdependent, a certain order of adjustment is often necessary. The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment.

Before any check, the instrument must attain its normal operating temperature.

- Warm-up time under average conditions is 30 minutes.
- Adjustments should be made after 2 hours
- Ambient temperature (23 ± 1)° C
- Mains voltage, nominal values ± 10 %
- The cabinet must be closed.*
- Where possible, instrument performance should be checked before an adjustment is made.
- All limits and tolerances given in this chapter are calibration guides, and should not be interpreted as instrument specifications unless they are also published in chapter 1.2. of the Operating Manual.
- Tolerances are given for the instrument under test and do not include test equipment error.
- If not explicitely stated otherwise, the voltage potentials refer to the relevant contact measured against measuring earth.

8.2. RECOMMENDED TEST EQUIPMENT

The following instruments are necessary to provide check and adjustment of the PM 5191

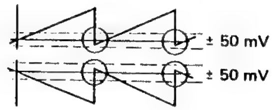
- 50 Ω termination resistor PM 9581 (1 W)
- wide band oscilloscope (tr ⩽ 3 ns)
- DC-voltmeter: resolution ⩽ 100 μV e. g. PM 2534
- counter 50 MHz, intervall-measurements, 8 digits resolution, e. g. PM 6665
- rms voltmeter: resolution 1 μV, fmax = 2 MHz e. g. Fluke 8920 A; the connection cable together with the termination resistor must have an impedance of exactly 50 Ω
- distortion meter e. g. PM 6309
- modulation meter e. g. Rhode + Schwarz FAM with 20 dB attenuator

- service kit
  consisting of notch filter 100 kHz, low pass filter 5 kHz, adjustment covers and two adapter cables; to be ordered from SC Hamburg without service code number

* For adjustments special covers with holes for the adjusting elements are required. This parts are included in the service kit.

8.3. TABLE OF CHECKS AND ADJUSTMENTS

step	objective	c = check a = adjust	operation parameters, settings	adjusting elements	measured value, value to be adjusted	test point, output, measuring instruments	open output/ 50 Ω term.	comment
	POWER SUPPLY ADJUSTMENT							
1	+ 5 V supply	c	∿ /1 kHz/15 Vpp	–	5 ± 0.25 V	T1 pin 6, DC-voltmeter (DVM)	–	
2	± 24V supply	c (a)	∿ /1 kHz/15 Vpp	604, 612, power supply	± 24 ± 0.05 V	T1 pin 4, 5, DC-voltmeter (DVM)	–	
3	+ 20V supply	c (a)	∿ /1 kHz/15 Vpp	607, power supply	+ 20 ± 0.05 V	T1 pin 3, DC-voltmeter (DVM)	–	
4	± 10V supply	c (a)	∿ /1 kHz/15 Vpp	618, 621, power supply	± 10V ± 0.05 V	T1 pin 1, 2, DC-voltmeter (DVM)	–	
	DFS ADJUSTMENT							
5	frequency adjustment	a	⊓⊔ /1 000 kHz/5 Vpp	505, DFS unit 2	1 MHz ± 0.3 Hz	OUTPUT connector, counter	50 Ω	
6	DFS-glitches	a	∿ /100 kHz/10 Vpp	676, 689, DFS unit 2	minimum AC level	OUTPUT connector, notch filter	–	the generator frequency must be exactly the same as the frequency of the notch filter (100 kHz)
	DC-ADJUSTMENT							
7	DFS DC-offset	a	∿ /1 kHz/15 Vpp	693, DFS unit 1	0 ± 1 mV	T12 unit 1, DC-voltmeter	–	
8	OUTPUT offset	a	∿ /1 kHz/15 Vpp	688, amplifier unit 1	0 ± 100 mV	T19 unit 1, DC-voltmeter	–	rough adjustment
9	DC-generator voltage	a	∿ /1 kHz/0 Vpp/–10 Vdc/AC OFF	698, amplifier unit 1	– 10 V ± 5 mV	OUTPUT connector, DC-voltmeter	–	
10	DC-generator voltage	a	∿ /1 kHz/0 Vpp/+ 10 Vdc/AC OFF	694, amplifier unit 1	+ 10 V ± 5 mV	OUTPUT connector, DC-voltmeter	–	
11	DC-generator voltage	a	∿ /1 kHz/0 Vpp/0 Vdc/AC OFF	698, amplifier unit 1	0 ± 5 mV	OUTPUT connector, DC-voltmeter	–	iterate with steps 9 + 10
12	offset, scaler and ampl. preliminary stage	a	∿ /1 kHz/25 Vpp	691, modulator unit 1	0 ± 1 mV	T15 unit 1, DC-voltmeter	–	
13	offset, amplitude controller	a	∿ /1 kHz/25 Vpp	633, amplifier unit 1	0 ± 1 mV	T14 to ground of T15, DC-voltm.	–	up to ser. no. LO–00789 use series resistor 10 k Ω to T14
14	offset, amplifier	a	∿ /1 kHz/30 Vpp	688, amplifier unit 1	0 ± 10 mV	OUTPUT connector, DC-voltmeter	–	

step	objective	a = adjust c = check	operation parameters, settings	adjusting elements	measured value, value to be adjusted	test point, output, measuring instruments	open output/ 50 Ω term.	comment
	FREQUENCY RESPONSE							
15	LF-amplitudes difference	a	∿ /1.8 kHz/10 Vpp ∿ /1.8 MHz/10 Vpp	550, modulator unit 1	0 dB ref.* 0.15 ± 0.01 dB**	OUTPUT connector, rms-voltmeter	50 Ω	* 0 dB are to be adjusted at the voltmeter for reference ** related to reference
	LF-AMPLITUDE, DISTORTION							
16	LF-amplitude	a	∿ /10 kHz/10 Vpp	613, modulator unit 1	1.771 ± 0.001 V	OUTPUT connector, rms-voltmeter	50 Ω	
17	LF-amplitude	c	∿ /10 kHz/1.0 Vpp	–	0.177 ± 0.004 V	OUTPUT connector, rms-voltmeter	50 Ω	
18	LF-amplitude	c	∿ /10 kHz/0.1 Vpp	–	17.7 ± 0.6 mV	OUTPUT connector, tms-voltmeter	50 Ω	
19	distortion	c	∿ /1 kHz/10 Vpp ∿ /1 kHz/30 Vpp	–	< 0.3 % < 0.4 %	OUTPUT connector, distortion-meter	50 Ω	(For measurement with Rhode + Schwarz FAM use 20 dB attenuator)
	SAWTOOTH ADJUSTMENT							
20	offset pos. ramp	a	⟋ /1 kHz/10 Vpp	607, modulator unit 1	neg. peak: 0 ± 50 mV	OUTPUT connector, scope	50 Ω	
21	offset neg. ramp	a	⟍ /1 kHz/10 Vpp	602, modulator unit 1	pos. peak: 0 ± 50 mV	OUTPUT connector, scope	50 Ω	
22	rms-value	c	⟋ /1 kHz/15 Vpp ⟍ /1 kHz/15 Vpp	–	2.165 ± 0.04 V	OUTPUT connector, rms-voltmeter	50 Ω	
	SQUARE WAVE ADJUSTMENT							
23	half cycle	a	⊓⊔ /1 kHz/20 Vpp	603, pulse gen. unit 1	500 ± 0.2 μs	OUTPUT connector, intervall counter	50 Ω	
24	pos. amplitude	a	⊓⊔ /0.05 Hz/20 Vpp	624, pulse gen. unit 1	+ 10 ± 0.04 V	OUTPUT connector, DC-voltmeter	–	
25	neg. amplitude	a	⊓⊔ /0.05 Hz/20 Vpp	627, pulse gen. unit 1	–10 ± 0.04 V	OUTPUT connector, DC-voltmeter	–	
26	signalform	a	⊓⊔ /2 MHz/20 Vpp	505, modulator unit 1	minimum rise time without overshoot	T15, scope (tr ⩽ 3 ns)		
27	signalform	a	⊓⊔ /2 MHz/20 Vpp	525, amplifier unit 1	tr < 24 ns/tf < 24 ns	OUTPUT connector, scope	50 Ω	repeat alternating until the best square wave and rise/ fall times are reached
28	signalform	a	⊓⊔ /2 MHz/20 Vpp	627, amplifier unit 1	tr < 24 ns/tf < 24 ns	OUTPUT connector, scope	50 Ω	

step	objective	c = check a = adjust	operation parameters, settings	adjusting elements	measured value, value to be adjusted	test point, output, measuring instruments	open output/ 50 Ω term.	comment
29	duty-cycle	c (a)	⊓⊔ /2 MHz/20 Vpp	(614, pulse gen. unit 1)	50 ± 5 %	OUTPUT connector, scope	50 Ω	
30	rise/fall time	c	⊓⊔ /2 MHz/30 Vpp	–	< 33 ns	OUTPUT connector, scope	50 Ω	
31	rms-value	c	⊓⊔ /1 kHz/20 Vpp	–	5 ± 0.04 V	OUTPUT connector, rms-voltmeter	50 Ω	if this value isn't correct, repeat steps 27 + 28
32	aberrations	c	⊓⊔ /1 kHz/15 Vpp	–	< 2 %	OUTPUT connector, scope	50 Ω	aberrations related to amplitude O-peak
	AM-ADJUSTMENT							
33	modulation frequency	c	∿ /10 kHz/INT/15 Vpp	–	1000 ± 30 Hz	MOD OUT connector, counter	–	without termination
34	modulation frequency amplitude (rms)	a	∿ /10 kHz/INT/15 Vpp	647, modulator unit 1	0.3 ± 0.006 V	MOD OUT connector, rms-voltm.	–	without termination
35	modulation frequency amplitude (rms)	a	∿ /1 kHz/EXT/20 Vpp	684, modulator unit 1	1.768 ± 0.01 V	OUTPUT connector, rms-voltmeter	50 Ω	
36	modulation depth	a	∿ /1 MHz/INT/20 Vpp	686, modulator unit 1	30 ± 1 %	OUTPUT connector, modulation meter	50 Ω	LF-bandwidth 10 Hz – 20 kHz (for FAM use 20 dB attenuator!)
37	distortion	c	∿ /1 MHz/INT/20 Vpp	–	< 0.5 %	OUTPUT connector, distortion meter	50 Ω	(for FAM use 20 dB attenuator!)
38	LF-suppression	a	∿ /1 MHz/INT/20 Vpp	663, modulator unit 1	minimum level	OUTPUT connector, rms-volt-meter, low-pass filter	–	
39	DC-difference	a	∿ /2 MHz/EXT/15 Vpp ∿ /2 MHz/MOD OFF/15 Vpp	681, modulator unit 1	difference < ± 10 mV between "EXT" and "OFF"	OUTPUT connector, DC-voltmeter	–	value altered by potmeter 681 in mode "EXT"
	MISCELLANEOUS							
40	CLOCK-frequency	c	∿ /1 kHz/15 Vpp	–	8.589935 MHz ± 3 Hz	CLOCK OUT, counter	–	
41	CLOCK-level pp	c	∿ /1 kHz/15 Vpp	–	> 3.5 V	CLOCK OUT, scope	–	

step	objective	a = adjust c = check	operation parameters, settings	adjusting elements	measured value, value to be adjusted	test point, output, measuring instruments	open output/ 50 Ω term.	comment
42	frequency (external synchr.)	c	∿ /1 MHz/15 Vpp	–	1.164153 MHz ± 1 Hz	OUTPUT-connector, counter	50 Ω	external 10 MHz ± 10 Hz TTL-signal at CLOCK-INPUT
43	TTL OUT-frequency	c	∿ /2 MHz/15 Vpp	–	2 MHz ± 1 Hz	TTL OUT, counter	–	
44	TTL OUT-level	c	∿ /2 MHz/15 Vpp	–	> 3.5 V	TTL OUT, scope	–	
45	mod. depth (ext. mod.)	c	∿ /2 MHz/EXT/30 Vpp	–	50 ± 2 %	OUTPUT connector, modulation meter	50 Ω	external mod. signal (~) 1 kHz, 0.5 Vrms at MOD INPUT (for FAM use 20 dB attenuator!)
46	display brightness	a	see component lay-out UNIT3, keyboard/display	R 604, 606, 608	< 10 mA per display segment	pin 11, CIS-connector on UNIT2 (see component lay-out UNIT3, keyboard/display)		only necessary after a replacement of a display

9. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

9.1. GENERAL DIRECTIVES

- Take care that creepage distances and clearances have not been reduced
- Before soldering, wires:
- should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

9.2. SAFETY COMPONENTS

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 10.

9.3. CHECKING THE PROTECTIVE EARTH CONNECTION

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω. During measurement the mains cable should be moved. Resistance variations indicate a defect.

9.4. CHECKING THE INSULATION RESISTANCE

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

Note:
2 MΩ is a minimum requirement at 40° C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 MΩ).

9.5. TEST AFTER REPAIR AND MAINTENANCE

This part of the checking – and adjusting procedure represents the final check of the PM 5191. Bottom and top cover of the cabinet must be closed and the instrument must be warmed up for at least 2 hours. The check contains measurements of DC-levels, amplitudes and frequencies on following their specifications and furthermore test of modulation function. The sequence of the measurements is free selectable.

9.5.1. Frequency measurements

Object	Frequency setting	Toleranz	Measurement point
Frequency (carrier)	1 MHz	± 0.8 Hz	OUTPUT (50 Ω)
mod. Frequency	INT (fm 1 kHz fixed)	± 25 Hz	MOD OUT

9.5.2. Checking of the square-wave

Frequency	Amplitude	Measurement
2 MHz	25 Vpp	rise/fall time < 35 ns aberrations < 3 % ± 20 mVpp

9.5.3. Modulation measurement

Measurement point: BNC-connector OUTPUT (50 Ω termination)

Frequency	Modulation	Object	Tolerance
2 MHz	INT	mod. depth* (30 % fixed)	28.5 % ... 31.5 %

* (For measurement with Rhode & Schwarz FAM use 20 dB attenuator)

9.5.4. DC-measurements

Measurement point: BNC-connector OUTPUT

Waveform	Frequency	Modulation	AC	DC	Tolerance of DC-output (open circuit)
AC OFF	1 kHz	OFF	0	0	± 25 mV
AC OFF	1 kHz	OFF	0	−10 V	± 225 mV
AC OFF	1 kHz	OFF	0	− 5 V	± 125 mV
AC OFF	1 kHz	OFF	0	+ 5 V	± 125 mV
AC OFF	1 kHz	OFF	0	+ 10 V	± 225 mV
∿	1 kHz	OFF	4, 5, ..., 30 Vpp	0	setting ± 70 mV
⊓⊔	1 kHz	OFF	5,10,...,30 Vpp	0	setting ± 100 mV
∿	1 kHz	EXT	30 Vpp	0	± 80 mV

9.5.5. AC-measurements

Measurement point: BNC-connector OUTPUT (50 Ω termination)

Waveform	Frequency	Modulation	Setting Vpp	≙ Vrms with 50 Ω termin.	Tolerance	≙ max / min
∿	1 kHz	OFF	0.003	0.530 mV	± 10 %	0.583 / 0.477 mV
∿	1 kHz	OFF	0.01	1.768 mV	± 4 %	1.839 / 1.697 mV
∿	1 kHz	OFF	0.02	3.536 mV	± 3 %	3.642 / 3.30 mV
∿	1 kHz	OFF	0.05	8.839 mV	± 2.5 %	9.060 / 8.618 mV
∿	1 kHz	OFF	0.1	17.678 mV	± 2.5 %	18.120 /17.236 mV
∿	1 kHz	OFF	0.2	35.356 mV	± 2.3 %	36.169 /34.543 mV
∿	1 kHz	OFF	0.3	53.034 mV	± 2.4 %	54.307 /51.761 mV
∿	1 kHz	OFF	3.0	0.5303 V	± 1.5 %	0.5383 / 0.5223 V
∿	1 kHz	OFF	30.0	5.3033 V	± 1.2 %	5.3669 / 5.2397 V
∿	1 kHz	OFF	2.0	0.3535 V	± 1.5 %	0.3588 / 0.3482 V
∿	1 kHz	OFF	3.2	0.5657 V	± 1.2 %	0.5725 / 0.5589 V
∿	1 kHz	OFF	4.0	0.7071 V	± 1.2 %	0.7156 / 0.6986 V
∿	1 kHz	OFF	6.4	1.1314 V	± 1.2 %	1.1450 / 1.1178 V
∿	1 kHz	OFF	8.0	1.4142 V	± 1.2 %	1.4312 / 1.3972 V
∿	1 kHz	OFF	12.8	2.2628 V	± 1.2 %	2.2899 / 2.2356 V
∿	1 kHz	OFF	16.0	2.8285 V	± 1.2 %	2.8624 / 2.7946 V
∿	1 kHz	OFF	25.6	4.5255 V	± 1.2 %	4.5798 / 4.4712 V
⋀⋁	1 kHz	OFF	20.0	2.8867 V	± 1.2 %	2.9213 / 2.8521 V
⊓⊔	1 kHz	OFF	20.0	5.0000 V	± 1.5 %	5.0750 / 4.9250 V
⊿	1 kHz	OFF	10.0	1.4433 V	± 2 %	1.4722 / 1.4144 V
◺	1 kHz	OFF	10.0	1.4433 V	± 2 %	1.4722 / 1.4144 V
∿	10 kHz	OFF	30.0	5.3033 V	± 1.2 %	5.397 / 5.2397 V
∿	200 kHz	OFF	15.0	2.6517 V	± 1.3 %	2.6862 / 2.6172 V
∿	2.147 MHz	OFF	15.0	2.6517 V	± 4.5 %	2.7710 / 2.5324 V
∿	2.147 MHz	OFF	1.0	0.1767 V	± 5 %	0.1855 / 0.1679 V
∿	2.147 MHz	OFF	0.10	17.678 mV	± 6.5 %	18.827 /16.529 mV
∿	2.147 MHz	OFF	0.01	1.768 mV	± 7.5 %	1.901 / 1.635 mV
∿	1.8 MHz	OFF	15.0	2.6517 V	± 4.5 %	2.7710 / 2.5324 V
∿	1 MHz	OFF	15.0	2.6517 V	± 2 %	2.7047 / 2.5987 V
∿	1 kHz	EXT	30.0	2.6517 V	± 2 %	2.7047 / 2.5987 V
∿	10 kHz	EXT	30.0	2.6517 V	± 2 %	2.7047 / 2.5987 V

10. SPARE PARTS

10.1. GENERAL

The synthesizer/function generator PM 5191 is repaired on single component level. No complete boards and modules are available at Concern Service Eindhoven.
Loaded PROMs must be ordered directly via Philips Supply Center Hamburg (please note software version).
In case of difficult faults central repair facility of the complete instrument is possible on special request via repair procedure at Supply Center Hamburg.
Conversion of an existing instrument to a different version is not foreseen.

Standard Parts
Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts
In addition to the standard electronic components, some special components are used:
- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument marked with 'S' in the parts list.

ATTENTION: Both type of components may only be replaced by components obtained through your local Philips organisation.

10.2. STATIC SENSITIVE COMPONENTS

This instrument contains electrical components that are suspectible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

10.3. HANDLING MOS DEVICES

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the following precautions are recommended.

CAUTION: Testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should normally be connected to ground via a resistor.

10.4. SOLDERING TECHNIQUES

Working method:
- Carefully unsolder one after the other the soldering tags of the semi-conductor.
- Remove all superfluous soldering material. Use a sucking iron or sucking litze wire.
- Check that the tags of the replacement part are clean and pre-tinned on the soldering places.
- Locate the replacement semi-conductor exactly on its place, and solder each tag to the relevant printed conductor on the circuit board.

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250^{o} C. The use of solder with a low melting point is therefore recommended.
Take care not to damage the plastic encapsulation of the semi-conductor (softening point of the plastic is 150^{o} C).

ATTENTION: When you are soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to ground of the instrument.

Suitable soldering irons should have temperature control and different types of nozzles (pin point tips), e. g. Weller Magnastat WTCP or WECP, Ersa TC 70/24 V.

If a higher wattage-rating soldering iron is used on the etched circuit boards excessive heat can cause the etched circuit wiring to seperate from the board base material.
In general use short-time heating with high tip temperature at a small point, avoid long time heating.

10.5. PARTS LIST PM 5191

10.5.1. Mechanical parts

Cabinet

Item	Quantity	Order number	Description
A	1	5322 447 91368	Top cover
B	1	5322 447 91369	Bottom cover
C	4	5322 462 40756	Plastic foot
D	4	5322 462 44434	Rubber foot, adhesive
E	4	5322 492 64745	Locking clip
F	1	5322 401 10867	Tilting support
G	1	5322 447 91373	Rear panel
H	2	5322 462 40761	Rear bumper
I	1	5322 447 91372	Front panel
J	1	5322 447 91371	Window for display
K	1	5322 456 90259	Text plate PM 5191
L	1	5322 447 90502	Front plate edging (upper)
M	1	5322 460 60438	Front plate edging (lower)
N	1	5322 460 60433	Profile ornament
O	1	5322 456 90261	Profile ornament with text
P	2	5322 447 90501	Side piece
P	2	5322 263 70186	Handle assembly (rack), not shown
Q	1	5322 460 60432	Profile orn. long, perf. (left)
R	1	5322 460 60434	Profile orn. short (right)
R	1	5322 460 60431	Profile orn. short, perf. (right)
S	1	5322 498 50176	Rubber handle
T	1	5322 462 40759	Steel insert

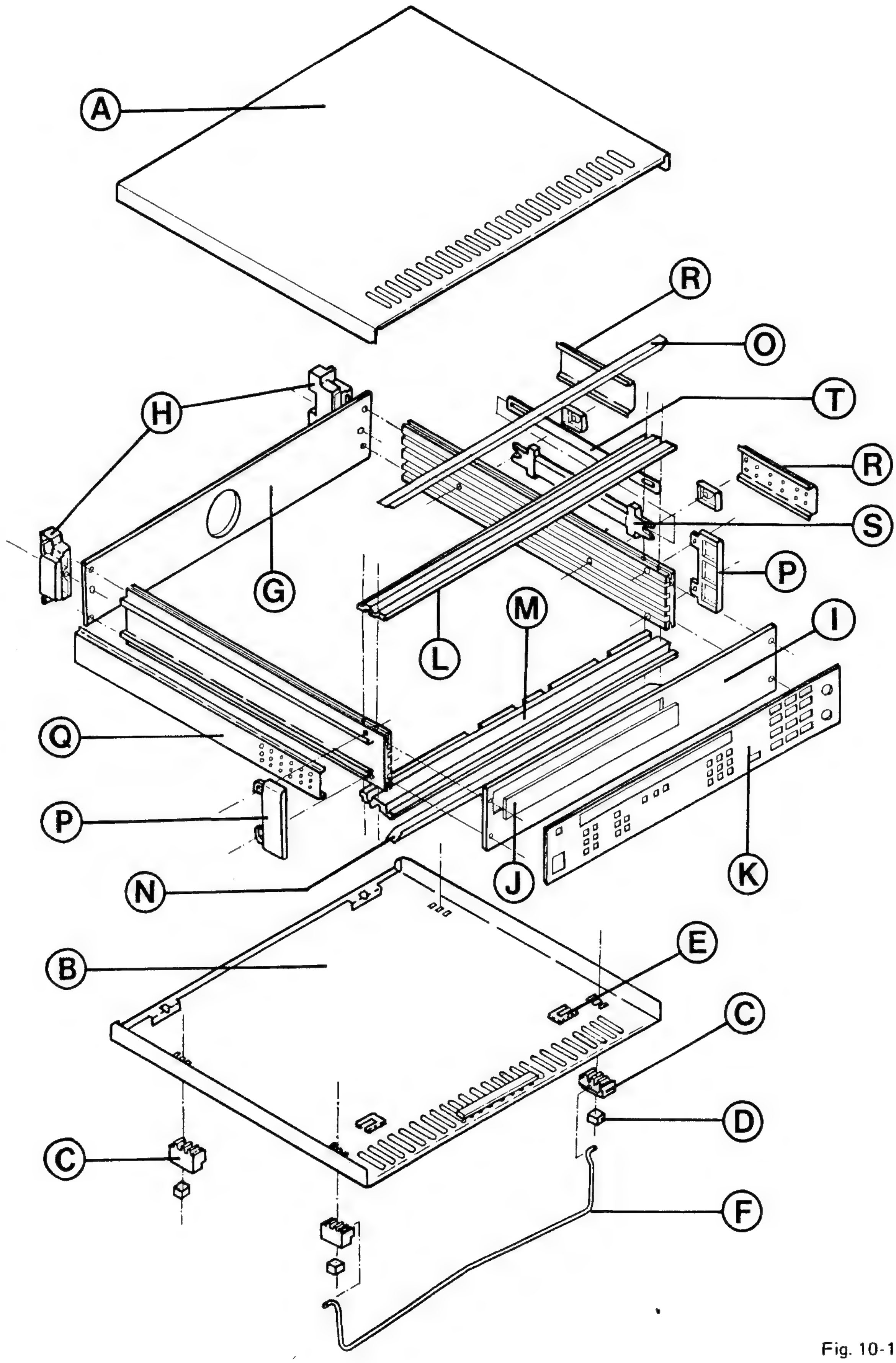


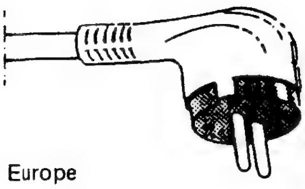
Fig. 10-1

10.5.2. Miscellaneaous, parts not on units

Item	Fig.	Quantity	Order number	Description
880	33 (31)	1	5322 276 12029 *S	Mains switch
881, 882	33 (31)	2	5322 267 10004	BNC connector, front
862-865	33 (32)	4	5322 267 10173	BNC connector, rear
	33 (32)	1	5322 321 22352	IEEE connector wired
870	33 (32)	1	5322 267 30416 *S	Mains socket with filter
	10-2	1	5322 321 10388 *S	Mains cable (Europe)
	10-3	1	5322 321 20816 *S	Mains cable (USA)
	10-4	1	5322 321 10123 *S	Mains cable (U. K.)
	32	1	5322 267 30328 *S	Fuse holder
869	33 (32)	1	4822 253 30018 *S	Fuse 630 mAT
869	33 (32)	1	4822 253 30022 *S	Fuse 1.25 AT
869	33 (32)	1	4822 253 30024 *S	Fuse 1.6 AT
868	33	1	5322 361 10451 *S	Fan
751	33	1	5322 146 30604 *S	Transformer
	31	13	5322 414 60037	Knob, large 12.5 x 6.5
	31	7	5322 414 60036	Knob, small 6.5 x 6.5
	31	17	5322 414 60038	Knob, small with LED
650, 651	33	2	5322 116 21068	Varistor (BNC front)
662-665	33	4	5322 116 21137	Varistor (BNC rear)
850, 851	33	2	5322 526 14034	Damping bead (BNC connector)
892-895		4	5322 526 14034	Damping bead (BNC connector)
	32	1	5322 462 44172	Cap for IC (rear panel)

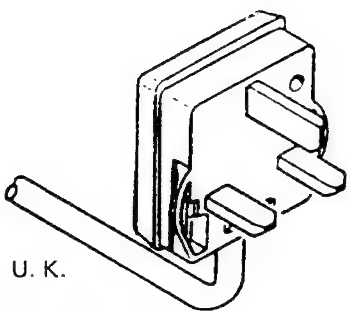
*S = Safety component, see chapter 10.1.

Mains cables



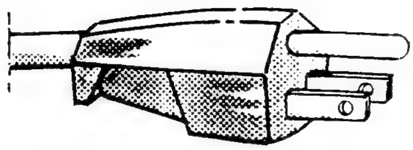
Europe

Fig. 10-2



U. K.

Fig. 10-3



U S A

Fig. 10-4

10.5.3. Electrical Parts

Some parts are listed in chapter 10.5.2.

From LO-02 691 onwards the instruments are fitted with dustproof potentiometers. Altered values and service code no. see page 10-17.

All metal film resistors not listed are of type MR 25 ± 1 % 0.4 W (ordering code see end of this list).

*1 Please order loaded PROM directly via Philips Supply Center Hamburg (note software version).

Pos. no.	Description				Ordering code
UNIT 1, POWER SUPPLY					
INTEGRATED CIRCUITS / UNIT 1, POWER SUPPLY					
301-306	Integr. circuit	MC1456N			5322 209 84688
305	Integr. circuit	Regulator LM223K			5322 209 71639 (rear wall)
TRANSISTORS / UNIT 1, POWER SUPPLY					
351, 356	Transistor	BD649			5322 130 41123
352, 357	Transistor	BD646			5322 130 41212
353, 358	Transistor	BC548B			4822 130 40937
354	Transistor	BC558B			4822 130 44197
355	Transistor	BD139			4822 130 40823
359, 360	Transistor	BC558B			4822 130 44197
DIODES / UNIT 1, POWER SUPPLY					
401	Rectifier	SKB2/08L5A			5322 130 32031
402, 403	Rectifier	BY260–200			4822 130 32145 (rear wall)
404, 406	Diode, reference	BZX79B18			4822 130 31024
405, 409	Diode, reference	BZX79B15			4822 130 34281
407, 414	Diode	BZV12			5322 130 34269
408	Diode, reference	BZX79B10			4822 130 34297
410	Diode, reference	BZX79B18			4822 130 31024
411	Diode, reference	BZX79B27			4822 130 34379
412, 415	Diode, reference	BZX79B4V7			4822 130 34174
413	Diode, reference	BZX79B7V5			4822 130 30861
416	Diode, reference	BZX79B13			4822 130 34195
417	Diode, reference	BZX75C1V4			4822 130 34047
CAPACITORS / UNIT 1, POWER SUPPLY					
501, 503	Cap. foil	220 nF	10 %	100 V	4822 121 40232
502, 504	Cap. electrolyt.	10 000 µF	20 %	63 V	5322 124 41278
505, 506	Cap. solid alu.	1 µF	10 %	50 V	4822 122 33108
508-510	Cap. foil	220 nF	10 %	100 V	4822 121 40232
512	Cap. foil	220 nF	10 %	100 V	4822 121 40232
511, 513	Cap. foil	4 700 µF		25 V	5322 124 21459
514, 515	Cap. electrolyt.	47 µF	50 %	25 V	4822 124 40433
517	Cap. electrolyt.	22 000 µF	20 %	16 V	5322 124 70435
518	Cap. solid alu.	1 µF	40 %	25 V	4822 124 20944
519-529	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
530-533	Cap. electrolyt.	47 µF	50 %	25 V	4822 124 40433
534, 535	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108

Pos. no.	Description				Ordering code

RESISTORS / UNIT 1, POWER SUPPLY

604, 607	Potm. trimmer *	470 Ω	CERMET	0.5 W	5322 101 14047
612	Potm. trimmer *	470 Ω	CERMET	0.5 W	5322 101 14047
618, 621	Potm. trimmer *	470 Ω	CERMET	0.5 W	5322 101 14047
623-630	Res. metal film	2.05 Ω	1 %	0.6 W	4822 116 52984
631-634	Res. metal film	1.4 Ω	1 %	0.6 W	5322 116 80391

UNIT 1, AMPLIFIER

INTEGRATED CIRCUITS / UNIT 1, AMPL.

301-303	Integr. circuit	HEF4094BP	5322 209 10421
304-306	Integr. circuit	HEF4053BP	5322 209 10576
307	Integr. circuit	DAC–08EN	5322 209 11254
308	Integr. circuit	MC1458N	4822 209 81349
309, 310	Integr. circuit	FPQ2222	5322 209 86422
311	Integr. circuit	SN7406N	5322 209 86327

TRANSISTORS / UNIT 1, AMPL.

320, 346	Transistor	BC558B	4822 130 44197
321, 347	Transistor	BFW16A	5322 130 44015
322-339	Transistor	BSV78	5322 130 44093
340, 341	Transistor	BC548C	4822 130 44196
342, 343	Transistor	BSX20	4822 130 41705
344	Transistor	2N2894A	5322 130 44127
345, 353	Transistor	BSX20	4822 130 41705
348, 351	Transistor	BC548B	4822 130 40937
349, 350	Transistor	BC558B	4822 130 44197
352	Transistor	2N4035	5322 130 44201
354, 357	Transistor	BD139	4822 130 40823
355, 356	Transistor	BD140	4822 130 40824
358	Transistor	2N2905A	5322 130 40468
359	Transistor	2N2219A	5322 130 44034
360	Transistor	BC548B	4822 130 40937
361	Transistor	BC558B	4822 130 44197
362, 373	Transistor	BC548C	4822 130 44196
363, 375	Transistor	BC558C	5322 130 60068
364, 366	Transistor	BDX46	5322 209 82974
365, 367	Transistor	BDX43	5322 130 42085
368, 369	Transistor	BC548B	4822 130 40937
370, 371	Transistor	2N4035	5322 130 44201
372	Transistor	BD140	4822 130 40824
374	Transistor	BD139	4822 130 40823

* (see page 10-17)

Pos. no.	Description				Ordering code

DIODES / UNIT 1, AMPL.

401	Diode	BAW62	4822 130 30613
403	Diode, reference	BZX79B4V7	4822 130 34174
405-408	Diode, reference	BZX79B5V1	4822 130 34233
409, 410	Diode, reference	BZX79B7V5	4822 130 30861
411, 412	Diode	BAW62	4822 130 30613
413, 414	Diode, reference	BZV11	5322 130 34294
415, 416	Diode, reference	BZX79B9V1	4822 130 30862
417-424	Diode	BAX12A	5322 130 34605

CAPACITORS / UNIT 1, AMPL.

501	Cap. ceramic	10 pF	2 %	100 V	4822 122 32185
502, 505	Cap. ceramic	3.3 pF	0.25 pF	100 V	4822 122 31821
503	Cap. ceramic	6.8 pF	0.25 pF	100 V	4822 122 31049
504	Cap. ceramic	4.7 pF	0.25 pF	100 V	4822 122 31822
506	Cap. ceramic	18 pF	2 %	100 V	4822 122 31985
507, 508	Cap. ceramic	1.8 pF	0.25 pF	100 V	5322 122 32162
509	Cap. ceramic	1.5 pF	0.25 pF	100 V	5322 122 32101
510, 511	Cap. electrolyt.	220 µF	50 %	16 V	4822 124 40196
512-515	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
516, 519	Cap. solid alu.	22 µF	20 %	10 V	4822 124 20943
517	Cap. ceramic	470 pF	2 %	100 V	4822 122 32062
518	Cap. ceramic	22 pF		100 V	5322 122 32143
520, 521	Cap. electrolyt.	220 µF	50 %	16 V	4822 124 40196
522, 523	Cap. electrolyt.	100 µF		50 V	4822 124 21348
524	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
525	Cap. trimmer	20 pF			4822 125 50045
528-530	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
531	Cap. ceramic	12 pF	2 %	100 V	4822 122 31056
532, 533	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
536	Cap. electrolyt.	100 µF	50 %	10 V	4822 124 40178
542, 543	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
544	Cap. ceramic	10 nF	80 %	100 V	4822 122 30043
545	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
546, 547	Cap. ceramic	10 nF	80 %	100 V	4822 122 30043
548, 549	Cap. ceramic	220 pF	2 %	100 V	5322 122 34047
550-552	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
553, 554	Cap. electrolyt.	1 µF	50 %	63 V	4822 124 40242
555	Cap. ceramic	15 pF	2 %	100 V	4822 122 31823
556	Cap. ceramic	18 pF	2 %	100 V	5322 122 34064
557-559	Cap. ceramic	1 pF	0.25 pF	100 V	4822 122 30104
560-563	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
564, 571	Cap. ceramic	22 nF	80 %	63 V	4822 122 30103
565	Cap. ceramic	1.5 nF	10 %	500 V	4822 122 31169
566	Cap. ceramic	120 pF	2 %	100 V	4822 122 31348
567	Cap. ceramic	47 pF	2 %	100 V	4822 122 31072
568, 569	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
572, 574	Cap. ceramic	22 nF	80 %	63 V	4822 122 30103
573	Cap. ceramic	4.7 nF	80 %	63 V	4822 122 31125
576, 577	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108

Pos. no.	Description				Ordering code
RESISTORS / UNIT 1, AMPL.					
602	Res. metal film	100 Ω	5 %	1.6 W	4822 116 51098
603	Res. metal film	2.61 kΩ	0.1 %	0.125 W	5322 116 80322
604	Res. metal film	1.05 kΩ	0.1 %	0.25 W	5322 116 52451
605	Res. metal film	3.01 kΩ	0.1 %	0.25 W	5322 116 51777
606	Res. metal film	5.9 kΩ	0.1 %	0.125 W	5322 116 80323
612	Res. metal film	1.47 kΩ	0.1 %	0.125 W	5322 116 80319
613	Res. metal film	7.15 kΩ	0.1 %	0.125 W	5322 116 80324
614	Res. metal film	8.66 kΩ	0.1 %	0.125 W	5322 116 80325
615	Res. metal film	10.5 kΩ	0.1 %	0.125 W	5322 116 80314
627	Potm. trimmer *	220 Ω	CERMET	0.1 W	4822 100 10359
628	Res. metal film	332 Ω	1 %	0.6 W	5322 116 53329
633	Potm. trimmer *	47 kΩ	carb.	0.1 W	4822 100 10079
655-658	Res. metal film	2.05 kΩ	1 %	0.5 W	5322 116 55001
661-668	Res. metal film	68.1 Ω	1 %	0.5 W	5322 116 55166
669-672	Res. metal film	33 Ω	6 %	1.6 W	4822 116 51167
688	Potm. trimmer *	100 Ω	CERMET	0.5 W	5322 101 14011
694	Potm. trimmer *	1 kΩ	CERMET	0.5 W	4822 100 10254
698	Potm. trimmer *	4.7 kΩ	CERMET	0.5 W	5322 101 10509
699, 700	Res. metal film	10.5 kΩ	0.1 %	0.125 W	5322 116 80314
701, 704	Res. metal film	412 Ω	0.1 %	0.25 W	5322 116 80211
702, 703	Res. metal film	619 Ω	0.1 %	0.25 W	5322 116 80212
711, 712	Res. metal film	31.6 Ω	0.1 %	0.125 W	5322 116 80313
713, 716	Res. metal film	16.9 kΩ	0.1 %	0.125 W	5322 116 80326
714, 715	Res. metal film	31.6 Ω	0.1 %	0.125 W	5322 116 80313
733-736	Res. metal film	110 Ω	0.1 %	0.125 W	5322 116 80316
737, 742	Res. metal film	95.3 Ω	0.1 %	0.125 W	5322 116 80315
739, 749	Res. metal film	274 Ω	0.1 %	0.125 W	5322 116 80318
740, 750	Res. metal film	1.86 kΩ	0.1 %	0.125 W	5322 116 80321
741	Res. metal film	162 Ω	0.1 %	0.125 W	5322 116 80317
743-746	Res. metal film	110 Ω	0.1 %	0.125 W	5322 116 80316
747	Res. metal film	95.3 Ω	0.1 %	0.125 W	5322 116 80315
763	Res. metal film	100 Ω	1 %	0.6 W	5322 116 53126
764-767	Res. network	5 x 100 kΩ	5 %		5322 111 91096
798, 799	Res. metal film	68.1 Ω	1 %	0.5 W	5322 116 55166
814, 819	Res. metal film	390 Ω	5 %	1.6 W	4822 116 51104
COILS / UNIT 1, AMPL.					
851, 852	Coil	220 µH			5322 157 53012
854, 885	Coil	10 µH			5322 157 53092
855	Coil	220 µH			5322 157 53012
884	Wide band choke				5322 158 10271
RELAIS / UNIT 1, AMPL.					
801-808	Reed relais	5 V			5322 280 20281

* (see page 10-17)

Pos. no.	Description				Ordering code

UNIT 1, MODULATOR

INTEGRATED CIRCUITS / UNIT 1, MOD.

301, 303	Integr. circuit	HEF4053BP	5322 209 10576
302	Integr. circuit	HEF4094BP	5322 209 10421
304	Integr. circuit	LF355N	5322 209 86355
305	Integr. circuit	MC1495L	5322 209 71638
306	Integr. circuit	LF356N	5322 209 86422

TRANSISTORS / UNIT 1, MOD.

350, 354	Transistor	BC558B	4822 130 44197
352, 355	Transistor	BC548B	4822 130 40937
359	Transistor	2N2894A	5322 130 44127
361	Transistor	BSX20	4822 130 41705
378, 379	Transistor	BF450	4822 130 44237
380, 381	Transistor	BF240	4822 130 40902
382	Transistor	BC548B	4822 130 40937
383	Transistor	BC558B	4822 130 44197

DIODES / UNIT 1, MOD.

401, 402	Diode, ref.	BZX79B4V7	4822 130 34174
403, 404	Diode, ref.	BZX79B6V8	4822 130 34278
407, 408	Diode, ref.	BZX79B6V8	4822 130 34278
421	Diode, ref.	BZX79B8V2	4822 130 34382
429, 430	Diode, ref.	BZX79B4V3	4822 130 31554
431, 432	Diode, ref.	BZX79B4V7	4822 130 34174
433, 434	Diode, ref.	BZX79B4V3	4822 130 31554

CAPACITORS / UNIT 1, MOD.

504	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
505	Cap. trimmer	10 pF			4822 125 50062
510	Cap. ceramic	2.2 nF	10 %	100 V	4822 122 30114
512	Cap. ceramic	18 pF	2 %	100 V	4822 122 31061
513	Cap. ceramic	120 pF	2 %	100 V	4822 122 31685
514, 516	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
517, 519	Cap. ceramic	68 pF	2 %	100 V	4822 122 31349
521, 522	Cap. foil	12 nF	1 %	63 V	5322 121 54162
523-530	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
531, 532	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
547	Cap. ceramic	22 pF		100 V	5322 122 32143
548	Cap. ceramic	56 pF	2 %	100 V	4822 122 32027
549	Cap. ceramic	8.2 pF	0.25 pF	100 V	4822 122 31052
550	Cap. trimmer	20 pF			4822 125 50045
551	Cap. ceramic	220 pF	2 %	100 V	5322 122 34047

Pos. no.	Description				Ordering code
RESISTORS / UNIT 1, MOD.					
601	Res. metal film	1 kΩ	0.1 %	0.25 W	5322 116 52384
602, 607	Potm. trimmer *	4.7 kΩ	CERMET	0.5 W	5322 101 10509
604, 606	Res. metal film	2 kΩ	0.1 %	0.25 W	5322 116 51812
609, 611	Res. metal film	2 kΩ	0.1 %	0.25 W	5322 116 51812
613	Potm. trimmer *	470 Ω	CERMET	0.5 W	5322 101 14047
642	Res. N. T. C.	50 kΩ	20 %	3 mW	5322 116 34026
643	Res. N. T. C.	4.7 kΩ	20 %	0.6 W	4822 116 30021
647	Potm. trimmer *	1 kΩ	carb.	0.1 W	4822 100 10037
663, 681	Potm. trimmer *	10 kΩ	carb.	0.1 W	4822 100 10035
684	Potm. trimmer *	2.2 kΩ	CERMET	0.5 W	5322 101 14008
686, 691	Potm. trimmer *	470 Ω	carb.	0.1 W	4822 100 10038
COILS / UNIT 1, MOD.					
701	Choke	220 μH			5322 157 53012
751	Choke	0.33 μH			5322 157 53013
RELAIS / UNIT 1, MOD.					
810–815	Reed relais	5 V			5322 280 20281

* (see page 10-17)

Pos. no.	Description				Ordering code

UNIT 1, PULSE GENERATOR

INTEGRATED CIRCUITS / UNIT 1, PULSE GEN.

301	Integr. circuit	NE521N	5322 209 14441
305	Integr. circuit	N74S00N	5322 209 84167

TRANSISTORS / UNIT 1, PULSE GEN.

351	Transistor	BC548B	4822 130 40937
352, 354	Transistor	2N2894A	5322 130 44127
353, 355	Transistor	BSX20	4822 130 41705
356, 357	Transistor	2N2894A	5322 130 44127
358	Transistor	2N5583	5322 130 44033

DIODES / UNIT 1, PULSE GEN.

401, 402	Diode, ref.	BZX79B4V7	4822 130 34174
403	Diode, ref.	BZV462V0	4822 130 31248
404	Diode, ref.	BZX79B6V2	4822 130 34167
405, 408	Diode	BA481	5322 130 32239
409, 410	Diode, ref.	BZX75C2V8	4822 130 34048
411	Diode, ref.	BZX79B4V7	4822 130 34174
412, 413	Diode	BA481	5322 130 32239
414	Diode, ref.	BZX79B3V3	5322 130 31504
415	Diode	BAW62	4822 130 30613

CAPACITORS / UNIT 1, PULSE GEN.

501, 502	Cap. ceramic	10 nF		100 V	4822 122 31414
503	Cap. ceramic	220 pF	2 %	100 V	5322 122 34047
504, 505	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
507, 510	Cap. ceramic	10 nF		100 V	4822 122 31414
508, 509	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
510, 521	Cap. ceramic	10 nF		100 V	4822 122 31414
512-517	Cap. ceramic	100 nF	10 %	50 V	5322 122 33108
518, 519	Cap. solid alu.	10 μF	20 %	16 V	4822 124 21314
520	Cap. ceramic	100 nF	20 %	50 V	5322 122 33108

RESISTORS / UNIT 1, PULSE GEN.

603	Potm. trimmer *	100 kΩ	carb.	0.1 W	4822 100 10052
614, 624	Potm. trimmer *	4.7 kΩ	carb.	0.1 W	4822 100 10036
627	Potm. trimmer *	4.7 kΩ	carb.	0.1 W	4822 100 10036
650	Res. metal film	150 Ω	5 %	1.6 W	4822 116 51142

* (see page 10-17)

Pos. no.	Description				Ordering code

UNIT 2, CPU

INTEGRATED CIRCUITS / UNIT 2, CPU

301-304	Integr. circuit	MC3441AP			5322 209 85464
305	Integr. circuit	HEF4093BP			5322 209 14927
306	Integr. circuit	HEF4738VP			5322 209 14509
307	Integr. circuit	HEF40244BP			5322 209 10489
308	Integr. circuit	HEF40373BP			5322 209 10491
309, 310	Integr. circuit	HEF4014BP			4822 209 10296
311	Integr. circuit	HEF4094BP			5322 209 10421
312	Integr. circuit	HEF4514BP			5322 209 14051
314	Integr. circuit	N74LS363N			5322 209 81776
315*1	I. C. P2764	(PROM, software version)			
317	Integr. circuit	PC74HCUO4P			5322 209 11323
318	Integr. circuit	P8031U processor			5322 209 82034
319	Integr. circuit	N74LS390N			5322 209 86362
320	Integr. circuit	HEF4049BP			4822 209 10306
324	Integr. circuit	PCD8571P			4822 209 83571

DIODES / UNIT 2, CPU

401-404	Diode	BAW62			4822 130 30613

CAPACITORS / UNIT 2, CPU

501	Cap. solid alu.	3.3 μF	20 %	16 V	4822 124 20947
502	Cap. ceramic	220 pF	10 %	100 V	4822 122 30094
503	Cap. ceramic	22 pF		100 V	5322 122 32143
504	Cap. ceramic	27 pF	2 %	100 V	4822 122 30045
506	Cap. ceramic	22 pF	80 %	63 V	4822 122 30103
512	Cap. electrolyt.	220 μF	50 %	16 V	4822 124 40196
513	Cap. ceramic	22 pF	80 %	63 V	4822 122 30103

RESISTORS / UNIT 2, CPU

601, 602	Res. nerwork	8 x 4.7 kΩ	5 %	0.125 W	5322 116 90132
604, 605	Res. network	8 x 4.7 kΩ	5 %	0.125 W	5322 116 90132
609	Res. network	8 x 4.7 kΩ	5 %	0.125 W	5322 116 90132

CRYSTAL / UNIT 2, CPU

801	Crystal	10 MHz			5322 242 71724

MISCELLANEOUS / UNIT 2, CPU

802	Lithium cell	3V/160mAh			5322 138 10144

Pos. no.	Description		Ordering code

UNIT 2, DFS

INTEGRATED CIRCUITS / UNIT 2, DFS

Pos. no.	Description		Ordering code
301	Integr. circuit	PC74HCUO4P	5322 209 11323
302, 306	Integr. circuit	N74LS132N	5322 209 85201
303	Integr. circuit	SN74LS109AN	5322 209 85974
304, 305	Integr. circuit	N74LS02N	5322 209 85312
307-311	Integr. circuit	HEF4094BP	5322 209 10421
312-321	Integr. circuit	N74LS283N	5322 209 86052
322, 323	Integr. circuit	N74LS273N	5322 209 85792
324	Integr. circuit	N74LS174N	5322 209 81632
325, 326	Integr. circuit	N74LS273N	5322 209 85792
327	Integr. circuit	N74LS86N	5322 209 84997
328	Integr. circuit	N74LS153N	5322 209 85488
329	Integr. circuit	SN74LS151N	5322 209 86452
330	Integr. circuit	N74LS00N	5322 209 84823
331, 332	Integr. circuit	N74LS86N	5322 209 84997
333, 338	Integr. circuit	N74LS174N	5322 209 81632
334, 339	Integr. circuit	N74LS175N	5322 209 84999
335	Integr. circuit	N82S115N (sine ROM)	5322 209 82603
336, 337	Integr. circuit	N74LS157N	5322 209 81521
340, 341	Integr. circuit	N74LS86N	5322 209 84997
342	Integr. circuit	N74LS273N	5322 209 85792
343	Integr. circuit	N74LS175N	5322 209 84999
344, 345	Integr. circuit	N74S04N	5322 209 84475
346	Integr. circuit	MC1458N	4822 209 81349
347	Integr. circuit	SN74LS151N	5322 209 86452
348	Integr. circuit	HEF4050BP	4822 209 10261

TRANSISTORS / UNIT 2, DFS

Pos. no.	Description		Ordering code
401	Transistor	BC558B	4822 130 44197
402	Transistor	BC548B	4822 130 40937
403	Transistor	BC558C	5322 130 60068
404, 407	Transistor	BC558B	4822 130 44197
405, 406	Transistor	BC558C	5322 130 60068
408, 409	Transistor	BC558C	5322 130 60068
410, 413	Transistor	BC558B	4822 130 44197
411, 412	Transistor	BC558C	5322 130 60068
414, 415	Transistor	BC558C	5322 130 60068
416, 419	Transistor	BC558B	4822 130 44197
417, 418	Transistor	BC558C	5322 130 60068
420, 421	Transistor	BC558C	5322 130 60068
422, 425	Transistor	BC558B	4822 130 44197
423, 424	Transistor	BC558C	5322 130 60068
426, 427	Transistor	BC558C	5322 130 60068
428, 430	Transistor	BC558B	4822 130 44197
429	Transistor	BC558C	5322 130 60068
431	Transistor	BC548B	4822 130 40937

Pos. no.	Description				Ordering code
DIODES / UNIT 2, DFS					
451-460	Diode	BAW62			4822 130 30613
461, 463	Diode, ref.	BZX79B4V3			4822 130 31554
462, 464	Diode	BAW62			4822 130 30613
465, 467	Diode, ref.	BZW79B4V3			4822 130 31554
466, 468	Diode	BAW62			4822 130 30613
469, 471	Diode, ref.	BZX79B4V3			4822 130 31554
470, 472	Diode	BAW62			4822 130 30613
473, 475	Diode, ref.	BZX79B4V3			4822 130 31554
474, 476	Diode	BAW62			4822 130 30613
477	Diode, ref.	BZX79B4V3			4822 130 31554
CAPACITORS / UNIT 2, DFS					
501, 507	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
502	Cap. ceramic	22 pF	2 %	100 V	5322 122 32143
503	Cap. ceramic	56 pF	2 %	100 V	4822 122 32027
504	Cap. ceramic	33 pF	2 %	100 V	5322 122 32072
505	Cap. trimmer	2.5-27 pF		100 V	5322 125 54083
506	Cap. solid alu.	1 μF		25 V	4822 124 20944
511-517	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
518	Cap. electrolyt.	220 μF		16 V	4822 124 40196
519	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
520, 521	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
522	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
523, 524	Cap. ceramic	33 pF	2 %	100 V	5322 122 32072
525, 526	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
527	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
528, 532	Cap. ceramic	33 pF	2 %	100 V	5322 122 32072
529, 530	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
531	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
533, 534	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
535, 539	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
536, 540	Cap. ceramic	33 pF	2 %	100 V	5322 122 32072
537, 538	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
541, 542	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
543, 547	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
544, 548	Cap. ceramic	33 pF	2 %	100 V	5322 122 32072
545, 546	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
549	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
550, 551	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
553	Cap. ceramic	82 pF	2 %	100 V	4822 122 31237
554, 558	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
555, 556	Cap. ceramic	4.7 nF	10 %	100 V	4822 122 31125
559	Cap. ceramic	22 pF	2 %	100 V	5322 122 32143
560, 562	Cap. ceramic	180 pF	2 %	100 V	5322 122 31907
561	Cap. ceramic	10 pF	2 %	100 V	4822 122 32185
563	Cap. solid alu.	6.8 μF		25 V	5322 124 14081
564, 566	Cap. solid alu.	10 μF		16 V	4822 124 21314
565, 567	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103

Pos. no.	Description				Ordering code
RESISTORS / UNIT 2, DFS					
637	Res. metal film	619 Ω	0.1 %	0.25 W	5322 116 80212
639, 646	Res. metal film	1.87 kΩ	0.1 %	0.25 W	5322 116 80215
642, 649	Res. metal film	4.64 kΩ	0.1 %	0.25 W	5322 116 80216
643, 650	Res. metal film	1.69 kΩ	0.1 %	0.25 W	5322 116 80214
644, 651	Res. metal film	619 Ω	0.1 %	0.25 W	5322 116 80212
653, 660	Res. metal film	1.87 kΩ	0.1 %	0.25 W	5322 116 80215
656, 663	Res. metal film	4.64 kΩ	0.1 %	0.25 W	5322 116 80216
657, 664	Res. metal film	1.69 kΩ	0.1 %	0.25 W	5322 116 80214
658, 665	Res. metal film	619 Ω	0.1 %	0.25 W	5322 116 80212
667	Res. metal film	1.87 kΩ	0.1 %	0.25 W	5322 116 80215
670	Res. metal film	4.64 kΩ	0.1 %	0.25 W	5322 116 80216
671	Res. metal film	1.69 kΩ	0.1 %	0.25 W	5322 116 80214
672	Res. metal film	619 Ω	0.1 %	0.25 W	5322 116 80212
673	Res. metal film	11.5 kΩ	0.1 %	0.25 W	5322 116 51742
674	Res. metal film	9.53 kΩ	0.1 %	0.25 W	5322 116 80207
676	Potm. trimmer *	470 Ω	carb.	0.1 W	4822 100 10038
679	Res. metal film	1.87 kΩ	0.1 %	0.25 W	5322 116 80215
682, 683	Res. metal film	4.64 kΩ	0.1 %	0.25 W	5322 116 80216
684, 685	Res. metal film	1.69 kΩ	0.1 %	0.25 W	5322 116 80214
686	Res. metal film	11.5 kΩ	0.1 %	0.25 W	5322 116 51742
687	Res. metal film	9.53 kΩ	0.1 %	0.25 W	5322 116 80207
689	Potm. trimmer *	1 kΩ	carb.	0.1 W	4822 100 10037
693	Potm. trimmer *	4.7 kΩ	CERMET	0.5 W	5322 101 10509
CRYSTAL / UNIT 2, DFS					
810	Crystal	8.59 MHz			5322 242 72047
COILS / UNIT 2, DFS					
802	Wide band choke				5322 158 10271
803	Choke				5322 158 20458
804	Choke				5322 158 20459

* (see page 10-17)

Pos. no.	Description			Ordering code

UNIT 3, KEYBOARD DISPLAY

INTEGRATED CIRCUITS / UNIT 3

351	Integr. circuit	HEF4049BP		4822 209 10306
352	Integr. circuit	MM5450N		4822 209 10199
353	Integr. circuit	SAA3007		5322 209 72061

TRANSISTOR / UNIT 3

301	Transistor	BD646		4822 130 41212

DIODES / UNIT 3

409, 410	Diode	BAW62		4822 130 30613

LEDs, DISPLAYS / UNIT 3

401-404	LED	CQY54A		4822 130 31128
405-408	Display	LTM86. .	unt. LO-02 690	5322 130 90375
		SI35035	onw. LO-02 691	5322 130 90491

CAPACITORS / UNIT 3

501	Cap. electrolyt.	220 µH		16 V	4822 124 40196
502-504	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103
505, 506	Cap. ceramic	100 pF	2 %	100 V	4822 122 31316
508	Cap. ceramic	22 nF	+ 20/– 90 %	40 V	4822 122 30103

SWITCHES / UNIT 3

801, 829	Key switch	M75120001	5322 276 14338
802-817	Key switch	M75120051	5322 276 14418
819, 820	Key switch	M75120001	5322 276 14338
827-833	Key switch	M75120051	5322 276 14418
834, 841	Key switch	M75120001	5322 276 14338
842	Key switch	M75120051	5322 276 14418
843-858	Key switch	M75120001	5322 276 14338

MISCELLANEOUS / UNIT 3

860	Cer. resonator	455 kHz	5322 242 71606

From LO-02 691 onwards

CERMET and carbon potentiometers **replaced by** **dustproof potentiometers**

Value		Serv. code no.	Value	Serv. code no.
100 Ω	CERMET	5322 101 14011	100 Ω	5322 101 10873
100 Ω	carb.	4822 100 10075		
220 Ω	CERMET	4822 100 10359	250 Ω	5322 101 10874
220 Ω	carb.	4822 100 10019		
470 Ω	CERMET	5322 101 14047	500 Ω	5322 101 10871
470 Ω	carb.	4822 100 10038		
1 kΩ	CERMET	4822 100 10254	1 kΩ	5322 101 10872
1 kΩ	carb.	4822 100 10037		
2.2 kΩ	CERMET	5322 101 14008	2.5 kΩ	5322 101 10875
2.2 kΩ	carb.	4822 100 10029		
4.7 kΩ	CERMET	5322 101 10509	5 kΩ	5322 101 10876
4.7 kΩ	carb.	4822 100 10036		
10 kΩ	carb.	4822 100 10035	10 kΩ	5322 101 10869
22 kΩ	carb.	4822 100 10051	25 kΩ	5322 101 10877
47 kΩ	carb.	4822 100 10079	—— see note	———
100 kΩ	carb.	4822 100 10052	100 kΩ	10878

Note: Potentiometer used for UNIT 1, AMPLIFIER, pos. no. 633; altered to 25 kΩ

The dustproof potentiometers are mechanical compatible.
For instruments with CERMET and carbon potentiometers spare parts are available on stock too.

LACQUERED METAL FILM RESISTORS MR25

style	resistance range	tol. ±%	series	temperature coefficient ±ppm/°C	limiting voltage (r.m.s.) V	service code no. 5322 116 5 . . . . followed by
MR 25	4,99 Ω – 301 kΩ	1	E96	50 *	250	

* For resistance values lower than 49,9 Ω: 100 ppm/°C.

4,99	0568	16,5	4109	54,9	4445	182	4493	604	4528
5,11	4192	16,9	0627	56,2	4446	187	4494	619	4529
5,23	4113	17,4	4432	57,6	4447	191	4495	634	4531
5,36	4239	17,8	0418	59	4448	196	0676	649	4532
5,49	4102	18,2	4083	60,4	4449	200	4496	665	4533
5,62	4128	18,7	0895	61,9	4451	205	0669	681	4534
5,76	4413	19,1	4104	63,4	4375	210	4036	698	4037
5,90	1064	19,6	0473	64,9	4453	215	0457	715	0571
6,04	4114	20	1048	66,5	4454	221	4002	732	4535
6,19	1049	20,5	0678	68,1	4455	226	4497	750	4536
6,34	0862	21	4433	69,8	4456	232	4498	768	4537
6,49	4112	21,5	0677	71,5	4457	237	0679	787	4538
6,65	4414	22,1	0983	73,2	4458	243	0437	806	4539
6,81	4013	22,6	0491	75	4459	249	4499	825	4541
6,98	4103	23,2	4434	76,8	0494	255	4501	845	4542
7,15	4415	23,7	4014	78,7	0578	261	4502	866	4543
7,32	4416	24,3	4435	80,6	4461	267	4503	887	4544
7,50	4417	24,9	0903	82,5	4462	274	4504	909	4545
7,68	4418	25,5	4436	84,5	4463	280	4505	931	4546
7,87	4046	26,1	0876	86,6	4464	287	4506	953	4547
8,06	4419	26,7	4067	88,7	4465	294	4507	976	4548
8,25	4099	27,4	0493	90,9	4466	301	4508	1 K	4549
8,45	4421	28	0623	93,1	4467	309	4509	1 K02	4551
8,66	1051	28,7	4068	95,3	0569	316	4511	1 K05	4552
8,87	4101	29,4	4084	97,6	4468	324	4512	1 K07	4553
9,09	0863	30,1	0904	100	4469	332	4513	1 K1	4554
9,31	4422	30,9	4437	102	4471	340	4514	1 K13	4555
9,53	4258	31,6	4034	105	4472	348	4515	1 K15	0415
9,76	4423	32,4	4105	107	4473	357	0603	1 K18	4556
10	0452	33,2	0527	110	4474	365	4516	1 K21	4557
10,2	4111	34	4438	113	4475	374	4517	1 K24	4559
10,5	4071	34,8	4027	115	4476	383	4518	1 K27	0555
10,7	4424	35,7	4439	118	4477	392	4006	1 K3	0526
11	4059	36,5	0409	121	4426	402	4519	1 K33	4561
11,3	4425	37,4	4158	124	4478	412	4521	1 K37	0628
11,5	0838	38,3	0954	127	4479	422	0459	1 K4	4562
11,8	0738	39,2	4087	130	4481	432	4522	1 K43	4563
12,1	4069	40,2	0926	133	4482	442	0592	1 K47	0635
12,4	4427	41,2	4108	137	4483	453	4523	1 K5	4564
12,7	4261	42,2	1052	140	4484	464	0536	1 K54	0586
13	4082	43,2	0519	143	4485	475	4007	1 K58	0622
13,3	1047	44,2	0818	147	0766	487	0508	1 K62	4565
13,7	4428	45,3	0795	150	4486	499	4524	1 K65	4566
14	0839	46,4	0492	154	0506	511	4525	1 K69	4567
14,3	4429	47,5	0952	158	4487	523	4526	1 K74	0629
14,7	0412	48,7	0511	162	0417	536	0621	1 K78	5015
15	0902	49,9	4441	165	4488	549	0732	1 K82	4568
15,4	0925	51,1	4442	169	4489	562	4009	1 K87	0728
15,8	0861	52,3	4443	174	4491	576	4527	1 K91	4569
16,2	4431	53,6	4444	178	4492	590	0561	1 K96	4571

2K	4572	6K65	4604	22K1	4003	73K2	0666	243K	4733
2K05	0664	6K81	4012	22K6	0481	75K	4686	249K	4734
2K1	4573	6K98	4605	23K2	4645	76K8	4687	255K	4735
2K15	0767	7K15	4606	23K7	4646	78K7	0533	261K	4736
2K21	4574	7K32	4607	24K3	4647	80K6	4688	267K	4737
2K26	0675	7K5	4608	24K9	4648	82K5	4689	274K	4738
2K32	4575	7K68	4609	25K5	4649	84K5	4691	280K	4739
2K37	4576	7K87	0458	26K1	4651	86K6	4692	287K	4741
2K43	4004	8K06	4611	26K1	4652	88K7	4693	294K	4742
2K49	0581	8K25	4558	27K4	0559	90K9	4694	301K	4743
2K55	4577	8K45	4612	28K	0667	93K1	4297	316 K	5268
2K61	0671	8K66	4613	28K7	4653	95K3	0567	332 K	1184*
2K67	4578	8K87	4614	29K4	4654	97K6	4695	348 K	5499
2K74	0636	9K09	4615	30K1	4655	100K	4696	365 K	5641
2K8	4579	9K31	4616	30K9	4656	102K	4697	374 K	5457
2K87	0414	9K53	4617	31K6	4657	105K	4698	383 K	5335
2K94	4581	9K76	4618	32K4	4658	107K	4699	402 K	5283
3K01	0524	10K	4619	33K2	0482	110K	4701	412 K	5424
3K09	4582	10K2	4621	34K	4659	113K	4702	422 K	5247
3K16	0579	10K5	0731	34K8	4661	115K	4279	442 K	5458
3K24	4583	10K7	4622	35K7	4662	118K	4703	464 K	5207
3K32	4005	11K	4623	36K5	0726	121K	4704	475 K	1275
3K4	4584	11K3	0668	37K4	4663	124K	4705	499 K	5468
3K48	4585	11K5	4624	38K3	0483	127K	4706	511 K	5258
3K57	4586	11K8	4625	39K2	4664	130K	4707	536 K	4758
3K65	4587	12K1	0572	40K2	4665	133K	4708	562 K	1169
3K74	4588	12K4	4626	41K2	4666	137K	4709	590 K	5567
3K83	4589	12K7	0443	42K2	0474	140K	4259	619 K	5315
3K92	4591	13K	0522	43K2	4667	143K	4711	649 K	5331
4K02	4592	13K3	4627	44K2	4668	147K	4712	681 K	5284
4K12	4593	13K7	4628	45K3	4669	150K	4713	750 K	5532
4K22	0729	14K	4629	46K4	0557	154K	4714	806 K	1369
4K32	4594	14K3	4631	47K5	4671	158K	4715	825 K	1398
4K42	0556	14K7	4632	48K7	0442	162K	4716	866 K	1395
4K53	0631	15K	4001	49K9	0674	165K	4717	909 K	5533
4K64	0484	15K4	0479	51K1	0672	169K	4718	953 K	1368
4K75	4008	15K8	4633	52K3	4673	174K	4719	1MAO	5535
4K87	0509	16K2	0593	53K6	4674	178K	4721		
4K99	0523	16K5	4634	54K9	4675	182K	4722		
5K11	4595	16K9	4635	56K2	4676	187K	4723		
5K23	4596	17K4	4636	57K6	4677	191K	4724		
5K36	4597	17K8	4637	59K	4678	196K	4725		
5K49	4598	18K2	4638	60K4	4679	200K	4726		
5K62	4011	18K7	0558	61K9	0872	205K	4727		
5K76	4599	19K1	4639	63K4	4681	210K	4208		
5K9	0583	19K6	4641	64K9	0514	215K	4728		
6K04	4601	20K	4642	66K5	4682	221K	4038		
6K19	0608	20K5	4643	68K1	4683	226K	4729		
6K34	4602	21K	4644	69K8	4684	232K	4731		
6K49	4603	21K5	0451	71K5	4685	237K	4732		

* 4822 116 5....

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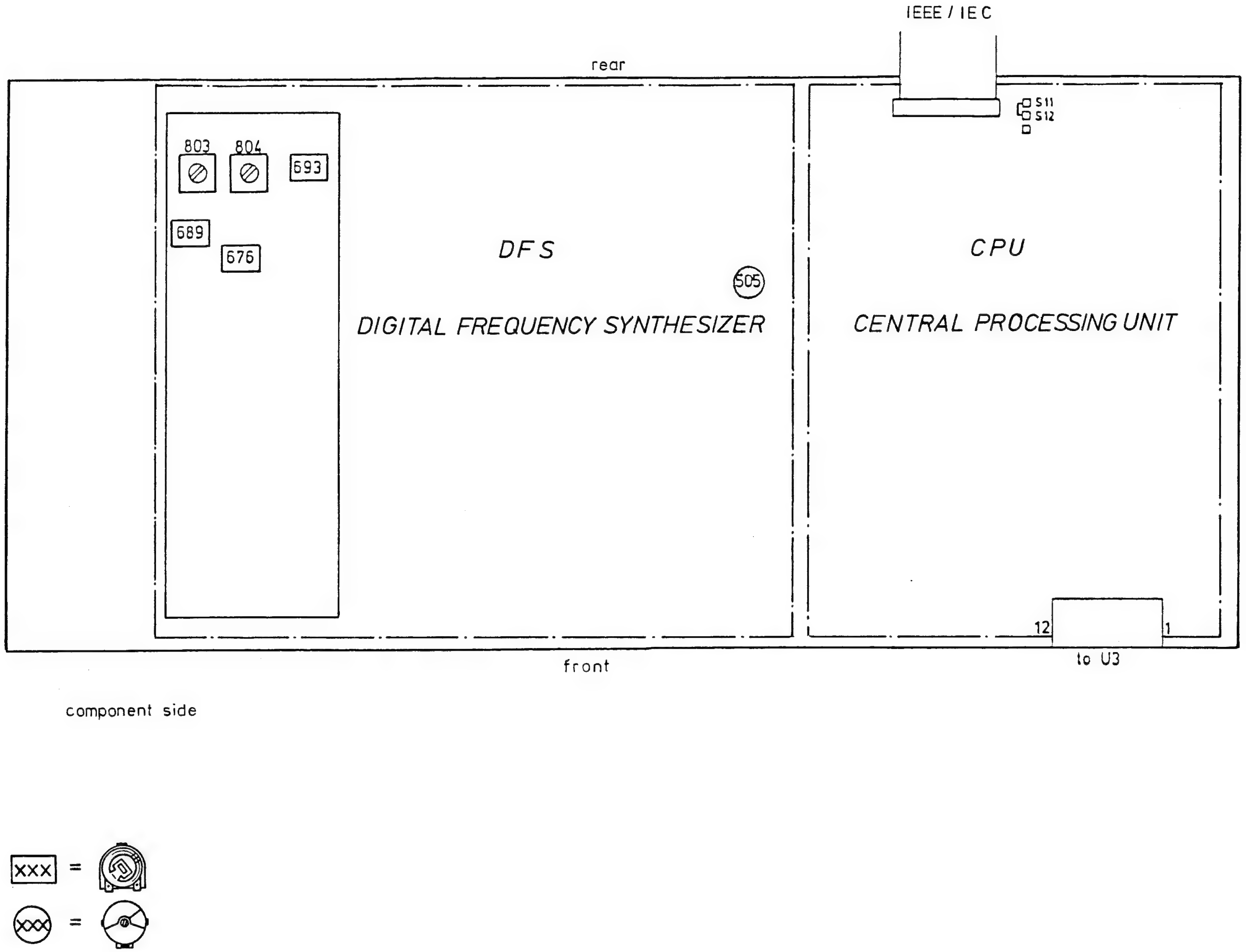
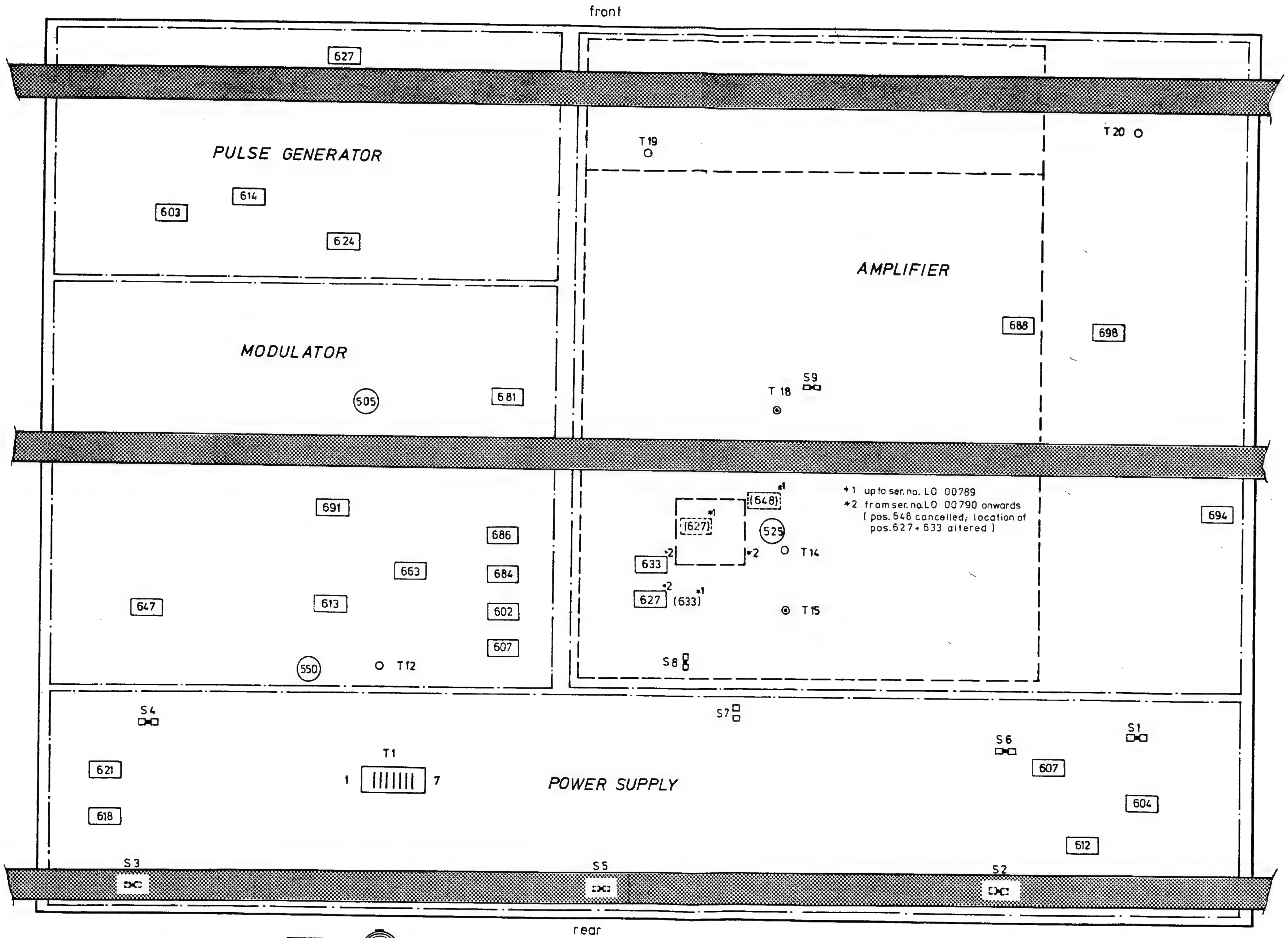


Fig. 28
Unit 2
adjusting elements



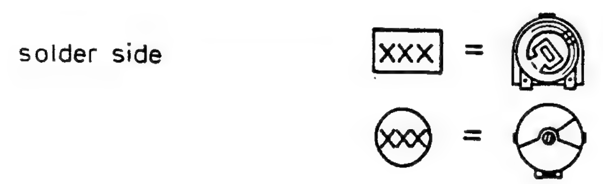


Fig. 29
Unit 1
adjusting elements

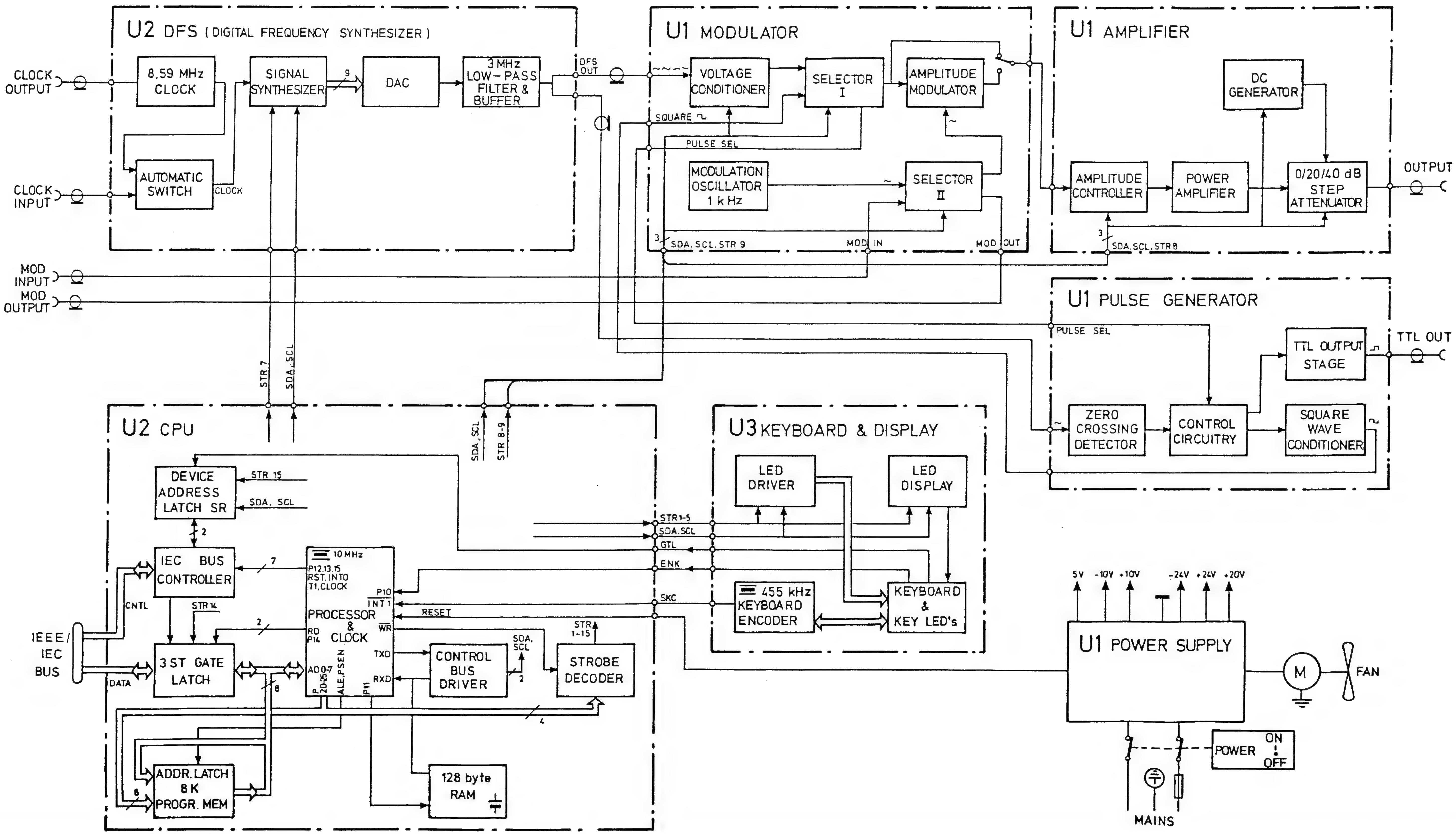


Fig. 30 Block diagram

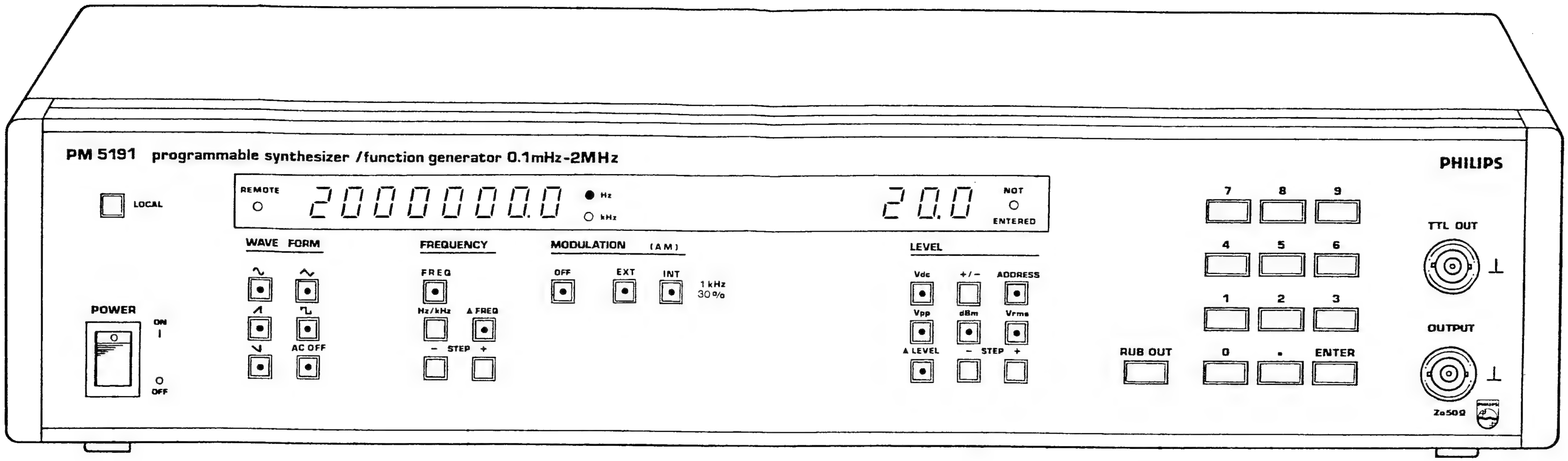


Fig. 31 Front view

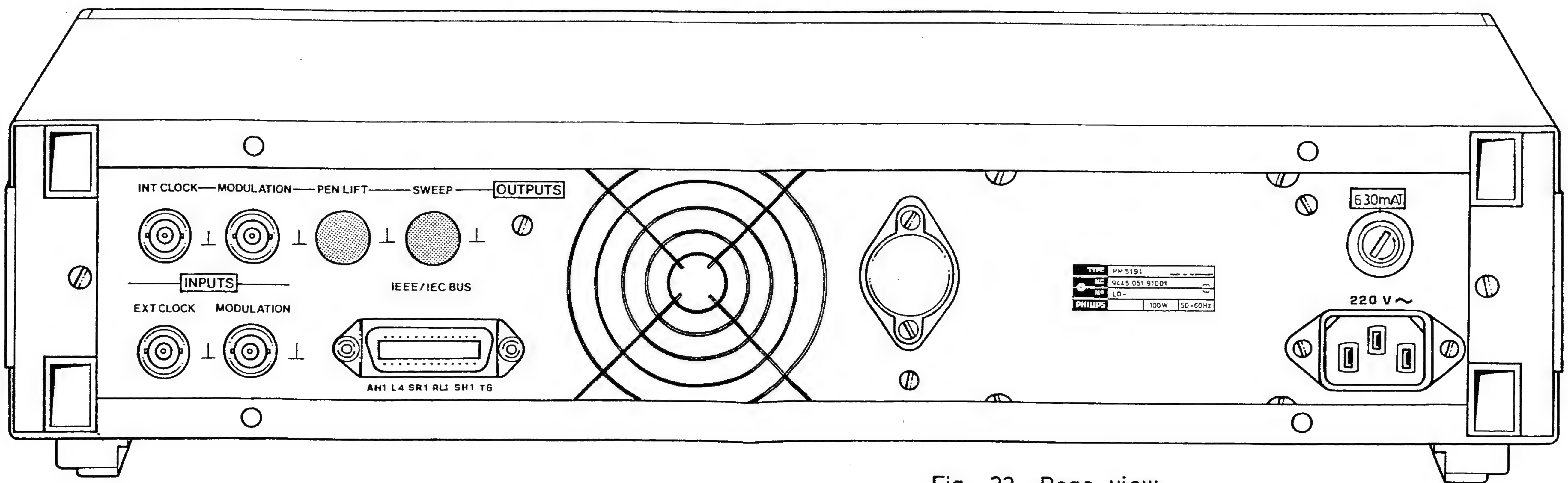
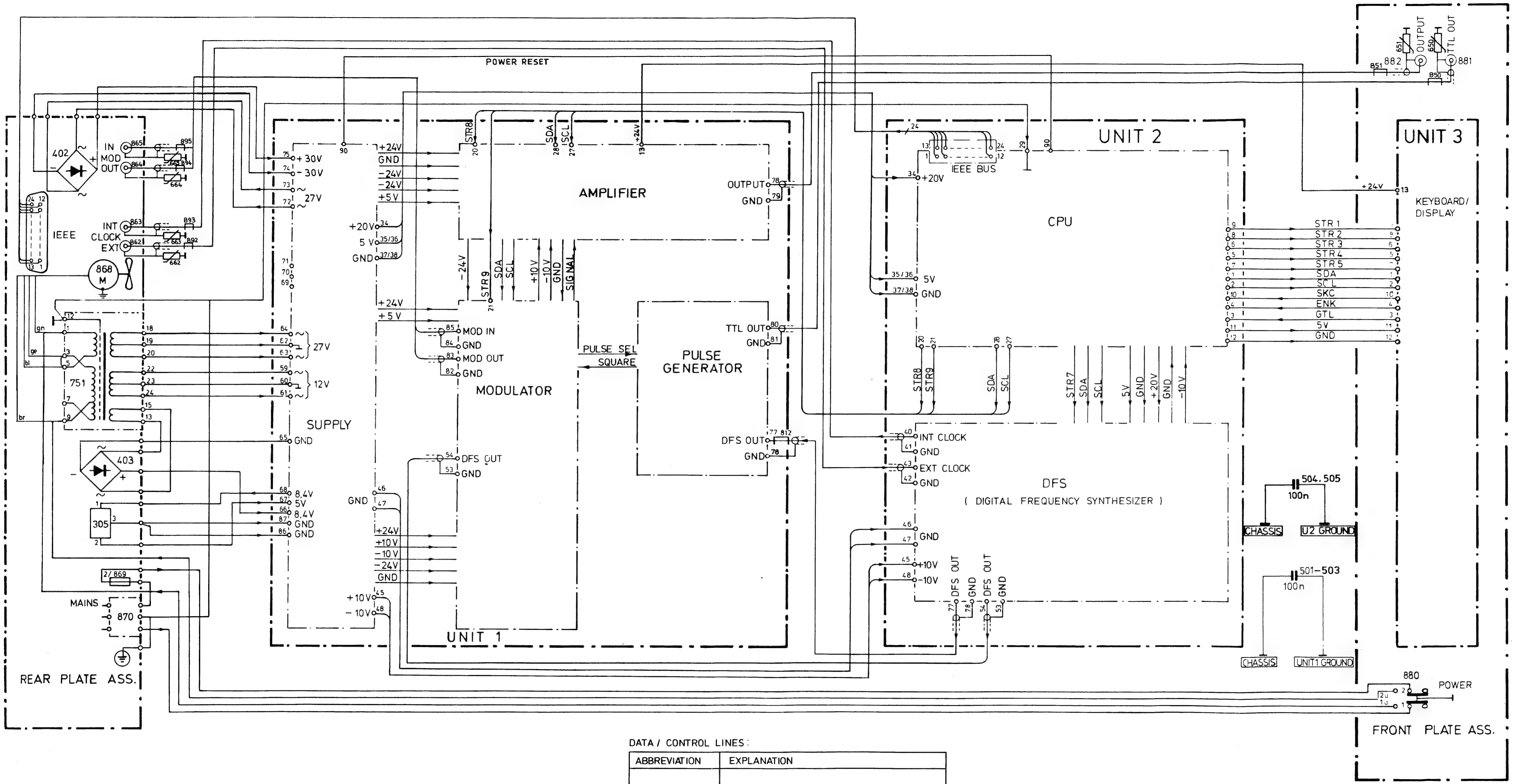


Fig. 32 Rear view

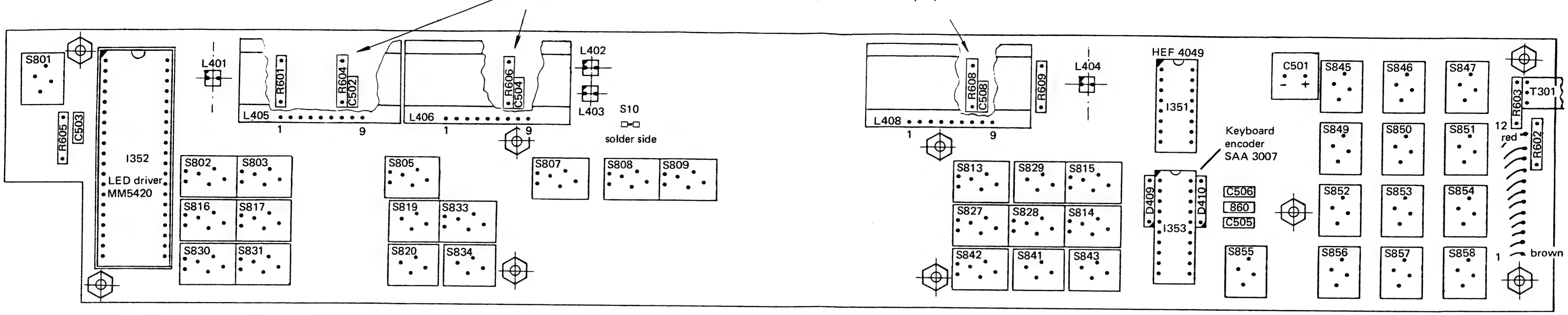


DATA / CONTROL LINES:

ABBREVIATION	EXPLANATION
SDA	SERIAL DATA LINE
SCL	SERIAL CLOCK LINE
PULSE SELECT	SQUARE WAVE SELECT
STR	STROBE
SKC	SERIAL KEYBOARD CODE
ENK	ENABLE KEYBOARD
GTL	GO TO LOCAL

Fig. 33 Overall circuitdiagram

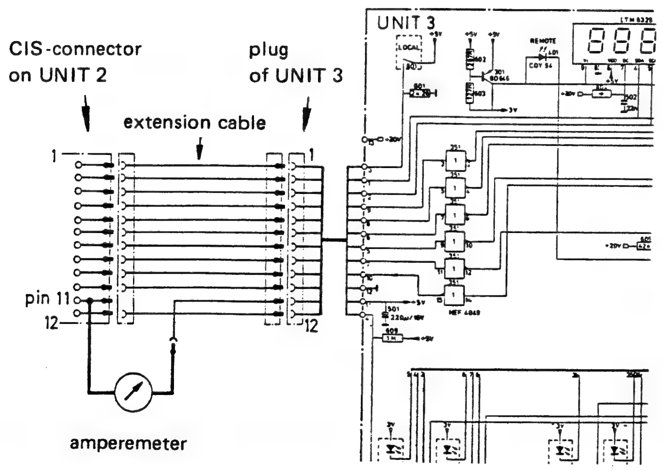
additional resistor on the solder side to adjust the brightness of the display



Brightness adjustment of displays

1. Open + 5 V supply of UNIT 3 at CIS-connector, pin 11, and connect an amperemeter.
   (It is recommended to use the extension cable of the service kit.)
2. Set the display you want to adjust to e. g. digit 1 (two segments) and measure current.
3. Set the display to e. g. 11 (two segments more than before) and measure current again.
   The difference may not exceed 10 mA per segment, in this case 20 mA;
   note that the decimal point is a segment too.
   Adjustment is done by resistor 604, 606 resp. 608.

Observe that no further display segments or LEDs are switched on or off, between both measurements.

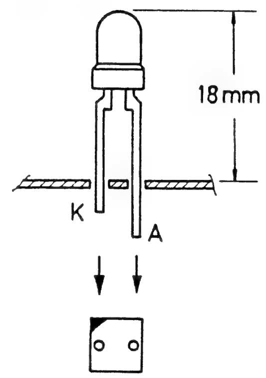


PM 5191 from LO - 02 691 onwards
is equipped with displays type SI 35035, serv. code no. 5322 130 90491

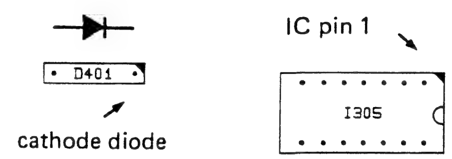
Distinction can easily be done by the space between the digits

- For instruments from LO - . . . onwards (see above) you should only build in the type SI 35035.
- For instruments up to above-mentioned LO - no. it is recommended to use still type LTM 86 . . . .
  If the stock is empty a new display can be built in;
  for this adjustment to the same brightness is necessary for the new one.
- If you want to replace all displays by new ones, you may do so.
  In this case a new adjustment for each display is necessary.

Mounting position of LEDs



Symbol identification:



Distinction of displays

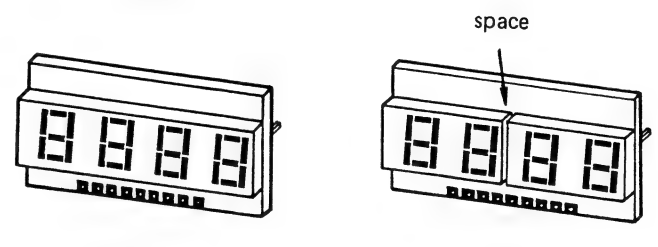
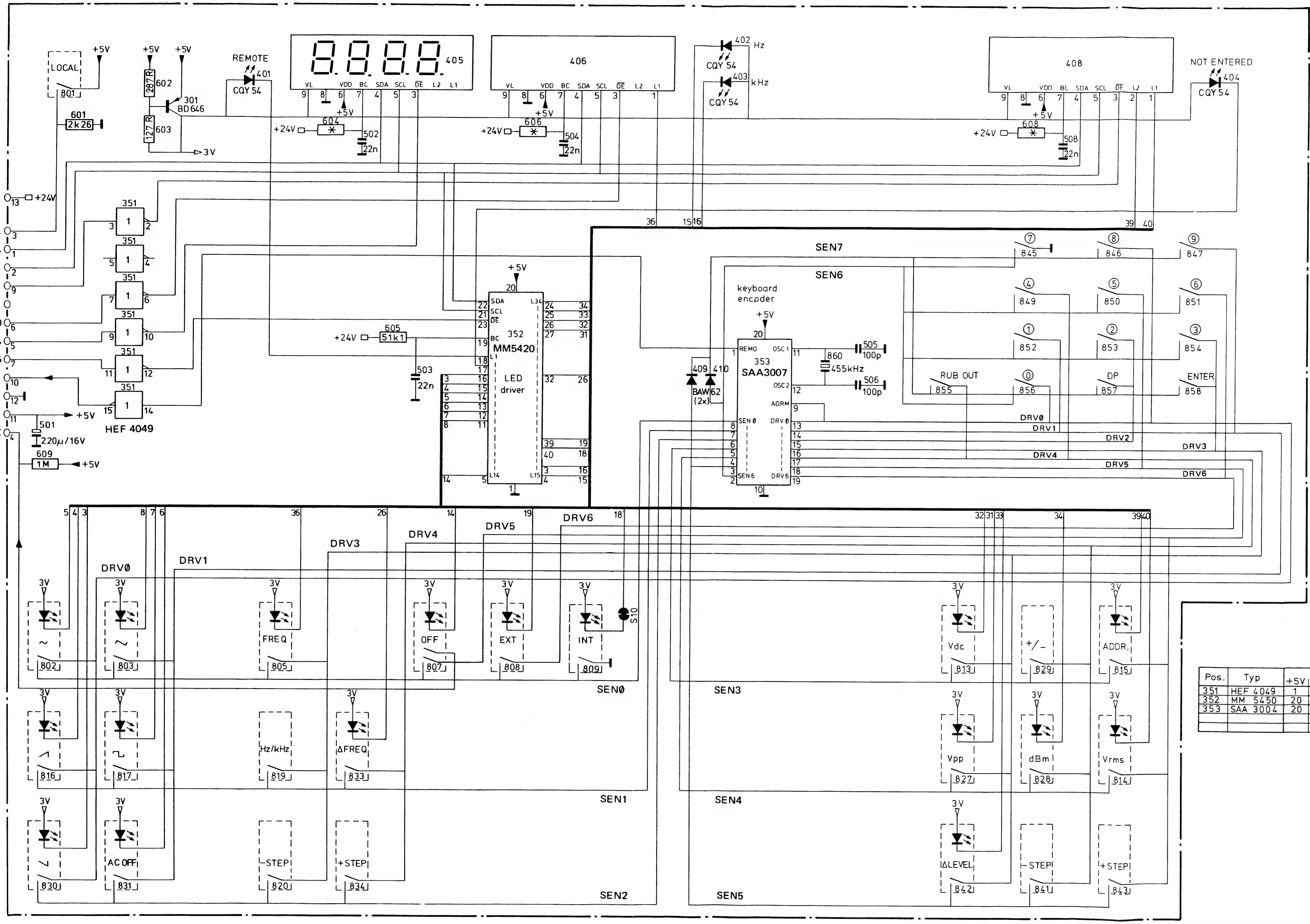
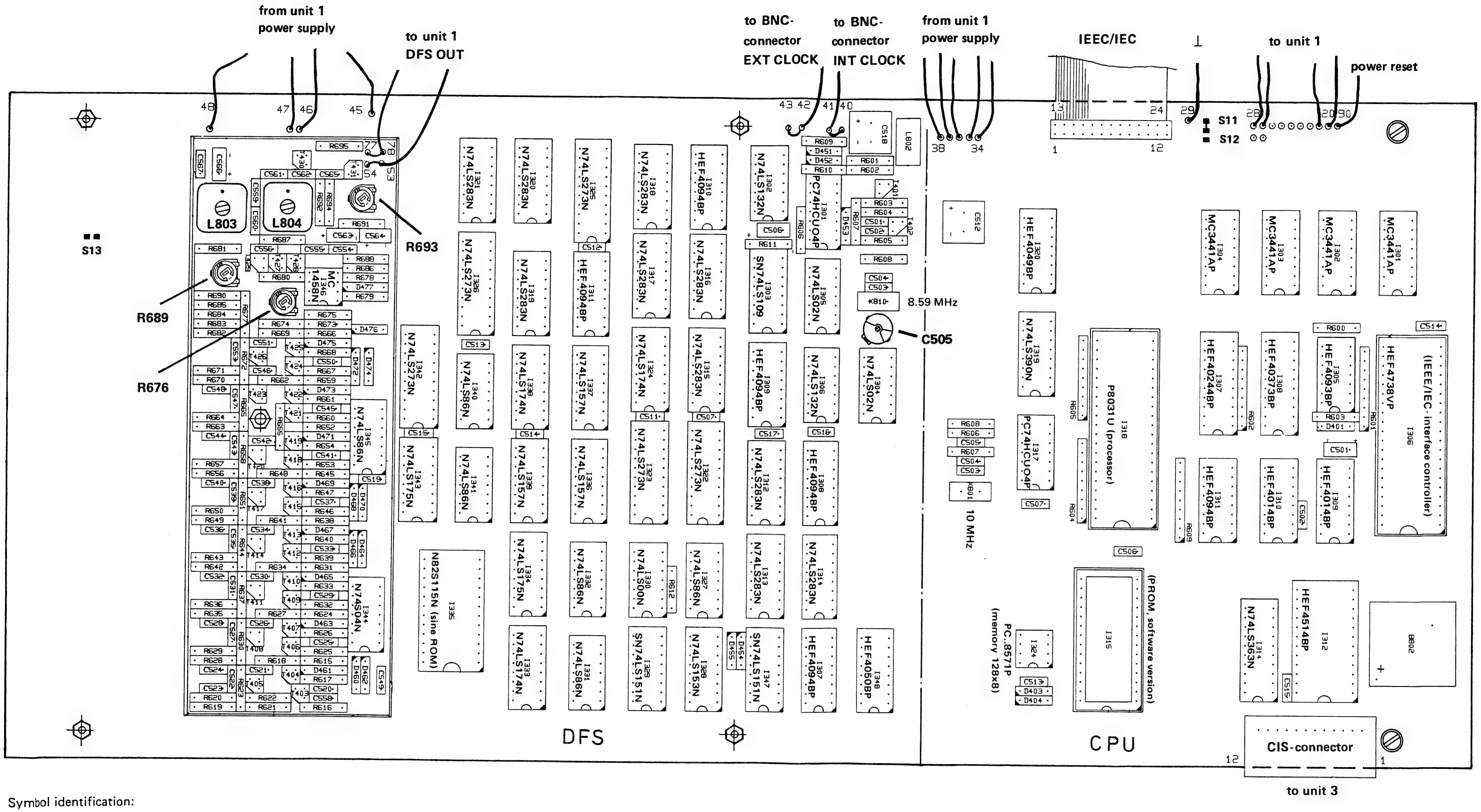


Fig. 34 Unit 3, keyboard / display component lay-out



Pos.	Typ	+5V	GND	DIL
351	HEF 4049	1	8	16
352	MM 5450	20	1	40
353	SAA 3004	20	10	20

Fig. 35 Unit 3,
keyboard / display



Symbol identification:

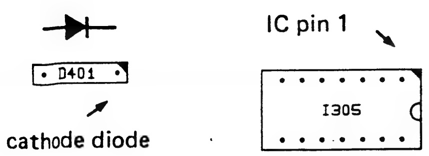
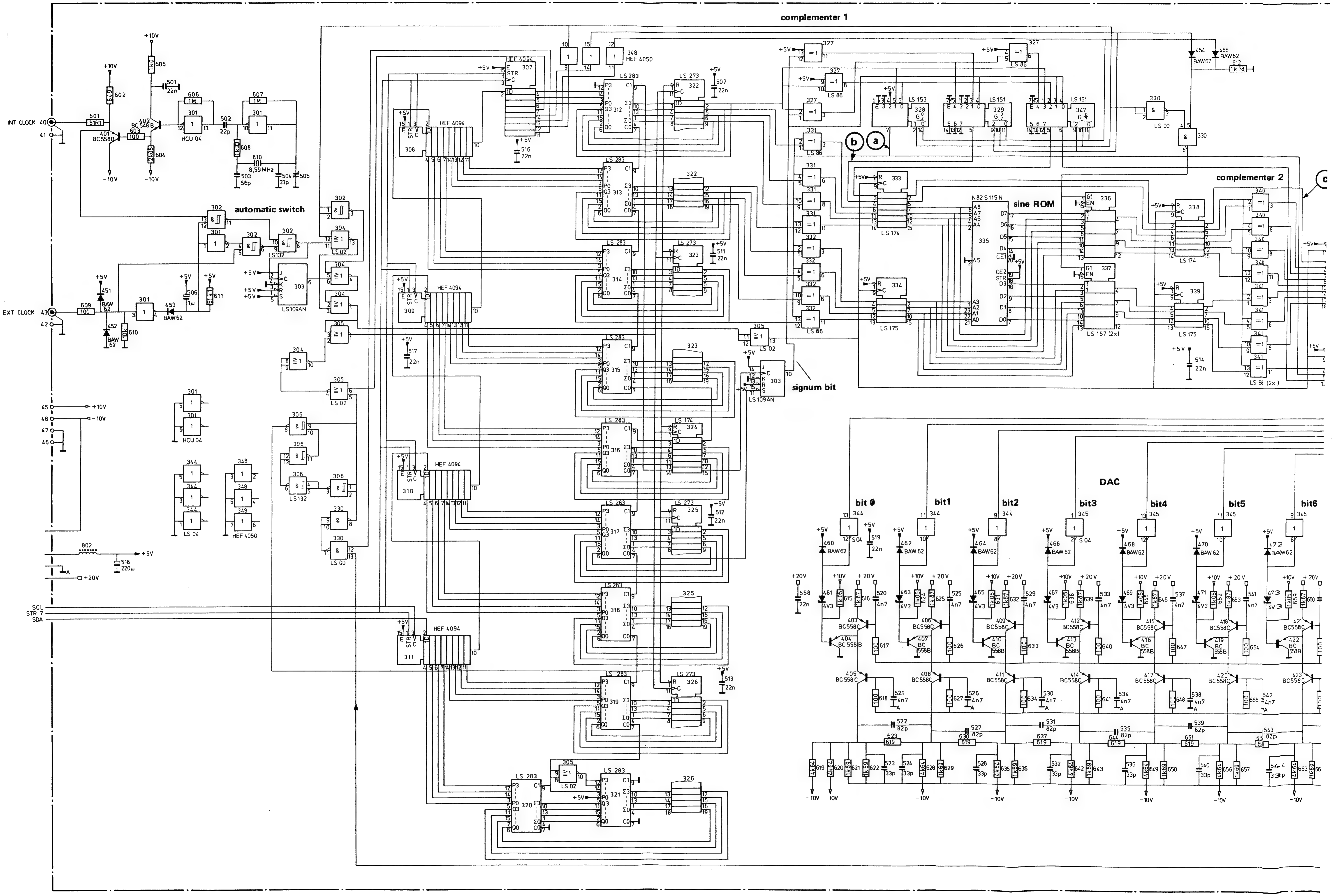
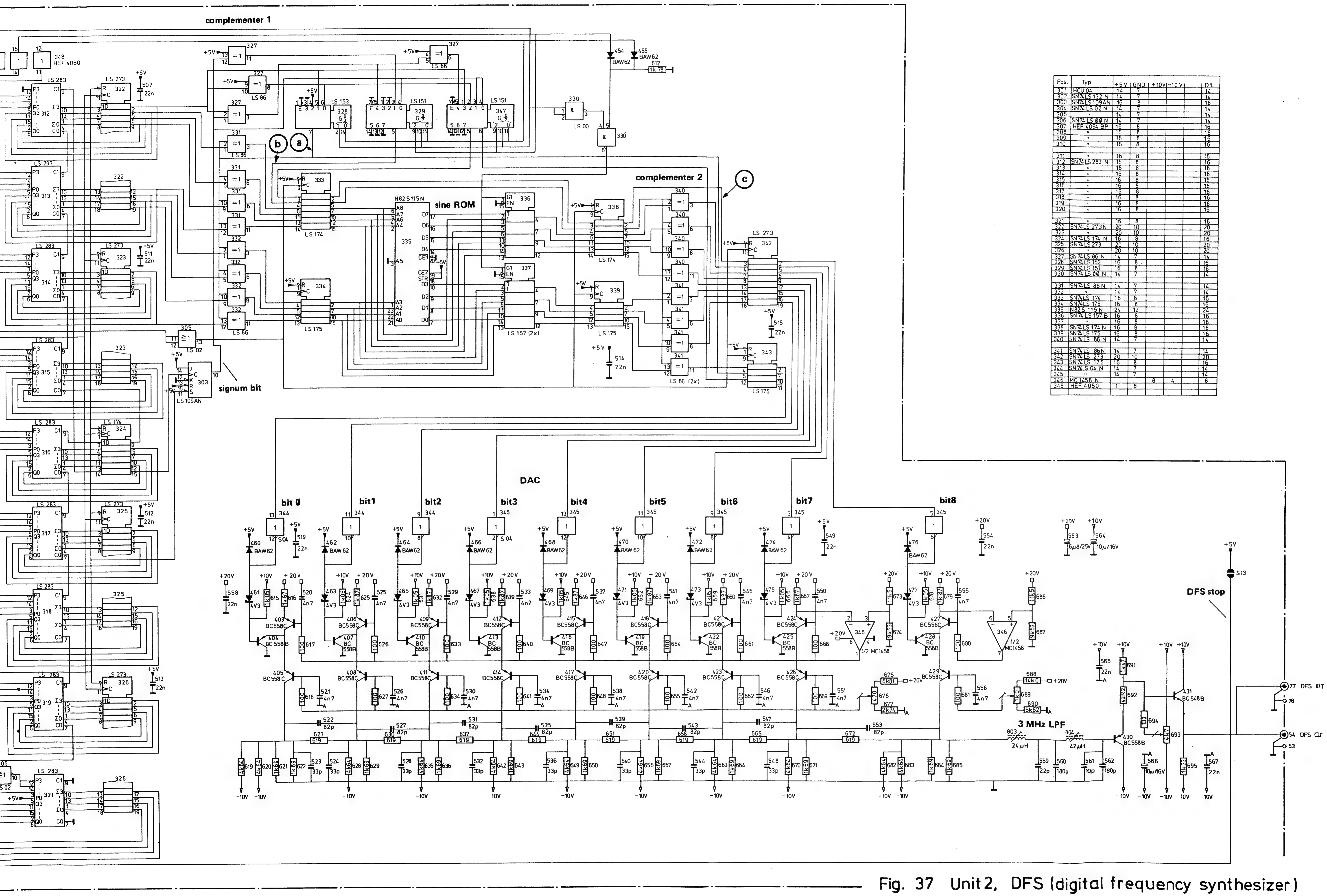


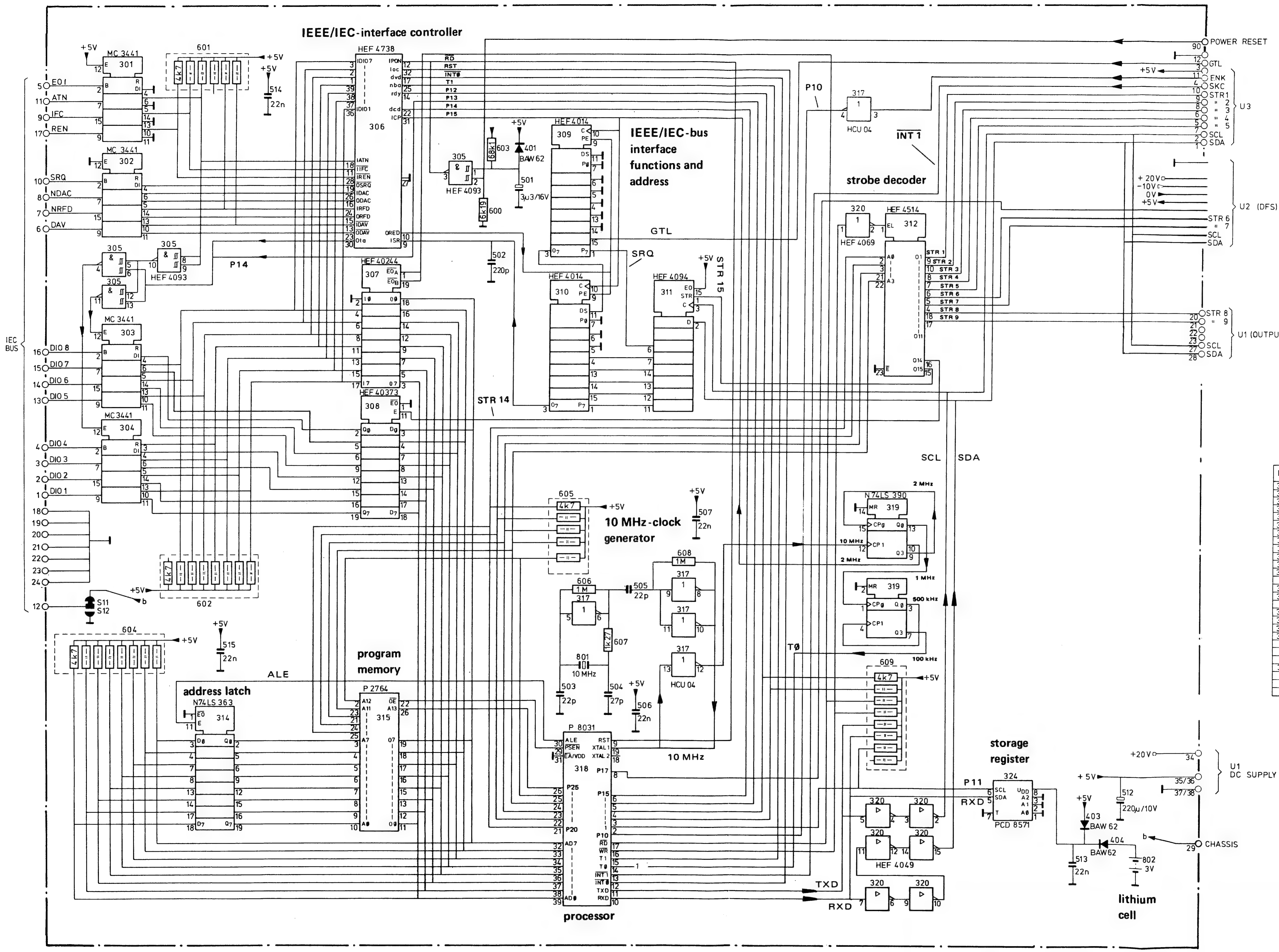
Fig. 36 Unit 2, DFS + CPU component lay-out


complementer 1
complementer 2
automatic switch
sine ROM
signum bit
DAC
INT CLOCK
EXT CLOCK
SCL
STR 7
SDA
bit 0
bit1
bit2
bit3
bit4
bit5
bit6

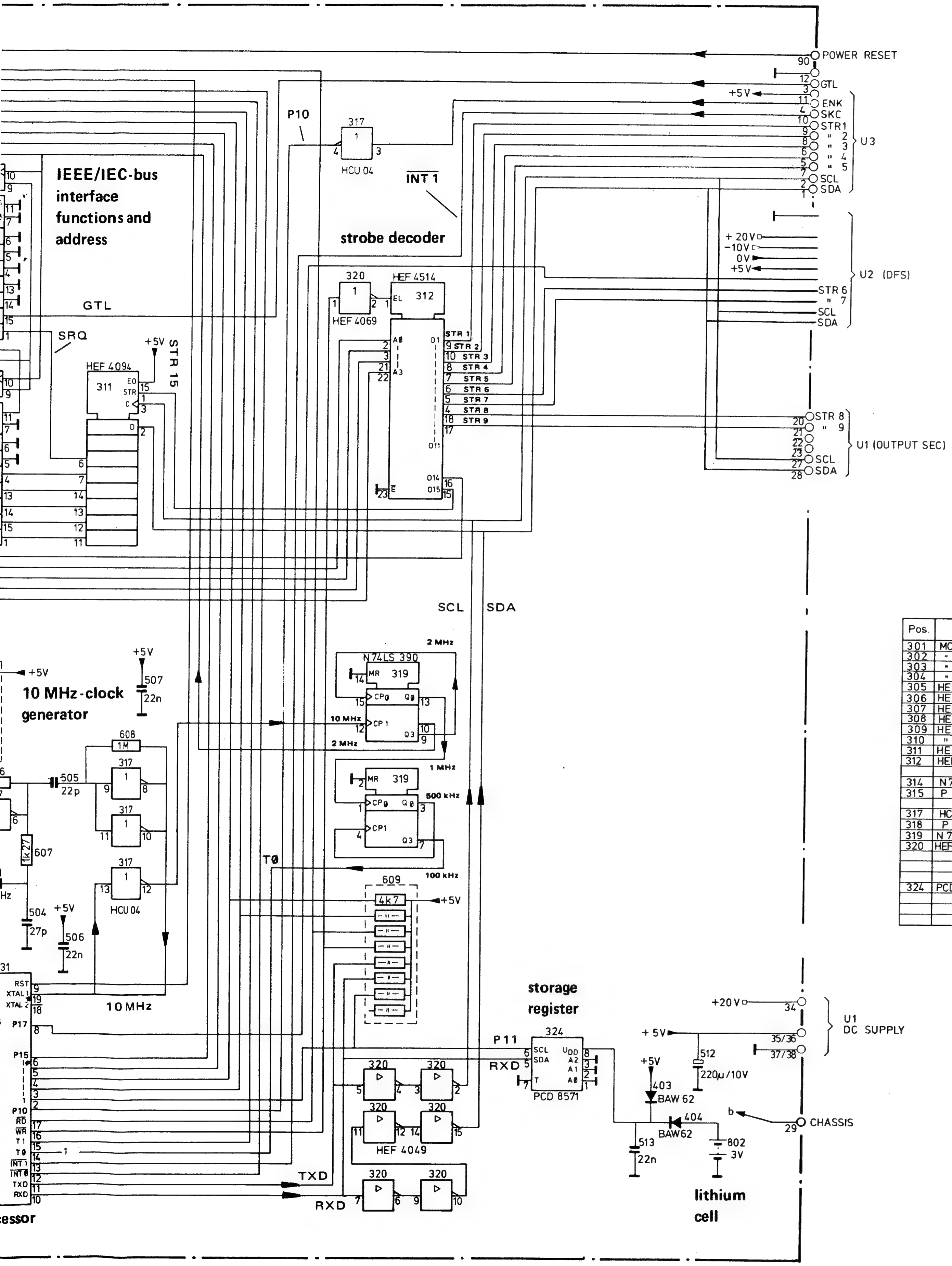


Pos.	Typ	+5 V	GND	+10V	−10 V		DIL
301	HCU 04	14	7				14
302	SN74LS 132 N	14	7				14
303	SN74LS 109AN	16	8				16
304	SN74 LS 02 N	14	7				14
305	"	14	7				14
306	SN74 LS ØØ N	14	7				14
307	HEF 4094 BP	16	8				16
308	"	16	8				16
309	"	16	8				16
310	"	16	8				16
311	"	16	8				16
312	SN74 LS 283 N	16	8				16
313	"	16	8				16
314	"	16	8				16
315	"	16	8				16
316	"	16	8				16
317	"	16	8				16
318	"	16	8				16
319	"	16	8				16
320	"	16	8				16
321	"	16	8				16
322	SN74LS 273N	20	10				20
323	"	20	10				20
324	SN74LS 174 N	16	8				16
325	SN74LS 273	20	10				20
326	"	20	10				20
327	SN74LS 86 N	14	7				14
328	SN74LS 153	16	8				16
329	SN74LS 151	16	8				16
330	SN74LS ØØ N	14	7				14
331	SN74LS 86 N	14	7				14
332	"	14	7				14
333	SN74LS 174	16	8				16
334	SN74LS 175	16	8				16
335	N82 S 115 N	24	12				24
336	SN74 LS 157 B	16	8				16
337	"	16	8				16
338	SN74LS 174 N	16	8				16
339	SN74LS 175	16	8				16
340	SN74LS 86 N	14	7				14
341	SN74LS 86N	14	7				14
342	SN74LS 273	20	10				20
343	SN74LS 175	16	8				16
344	SN74 S 04 N	14	7				14
345	"	14	7				14
346	MC 1458 N			8	4		8
348	HEF 4050	1	8				

Fig. 37 Unit 2, DFS (digital frequency synthesizer)

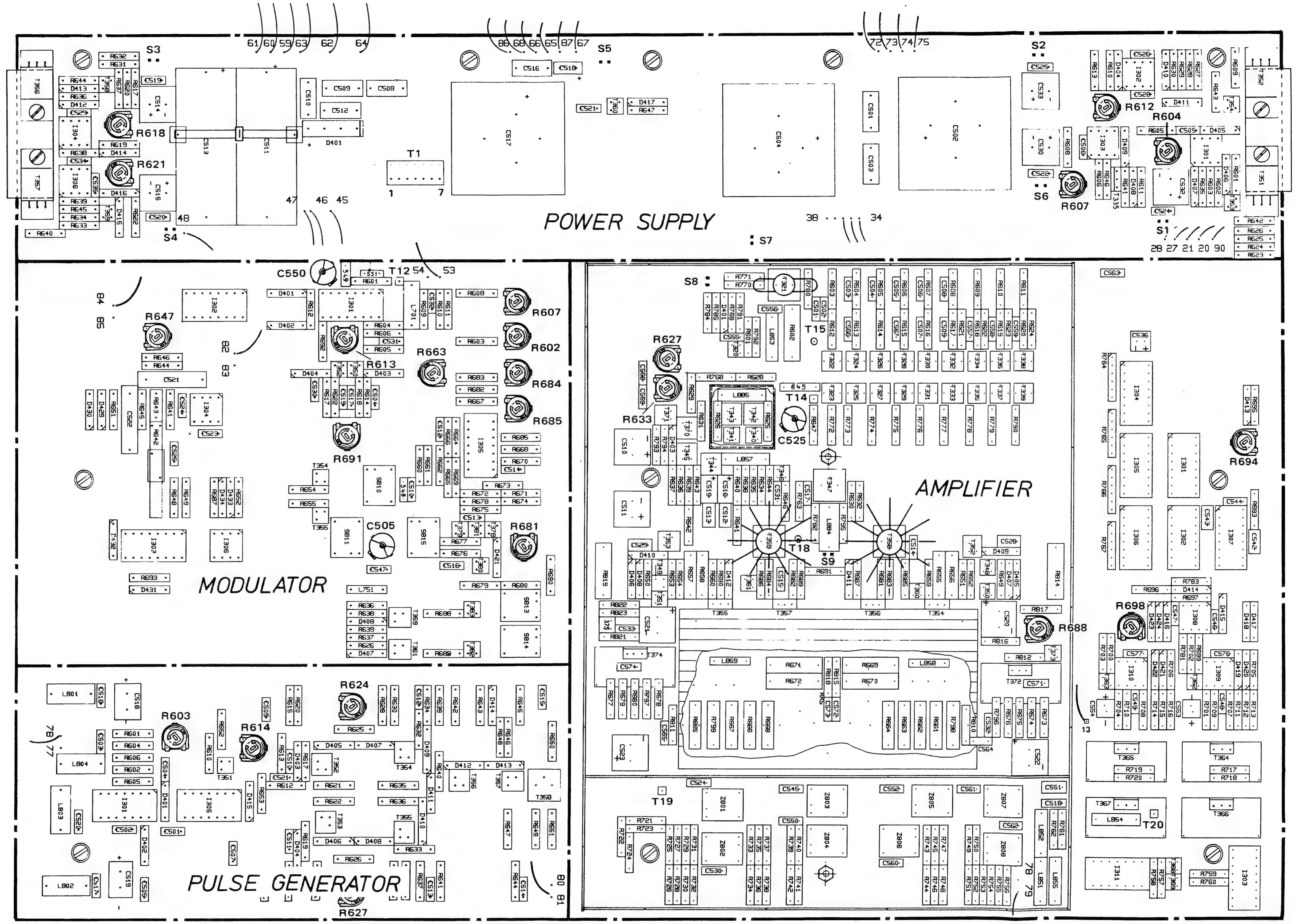


Pos.	Typ	Stromversorg. PIN +5V	GND	DIL
301	MC 3441	16	8	16
302	" "	16	8	16
303	" "	16	8	16
304	" "	16	8	16
305	HEF 4093	14	7	14
306	HEF 4738	40	20	40
307	HEF 40244	20	10	20
308	HEF 40373	20	10	20
309	HEF 4014	16	8	16
310	" "	16	8	16
311	HEF 4094	16	8	16
312	HEF 4514	24	12	24
314	N 74LS 363	20	10	20
315	P 2764	28	14	28
317	HCU 04	14	7	14
318	P 8031	40	20	40
319	N 74 LS 390	16	8	16
320	HEF4049	1	8	16
324	PCD 8571		4	8



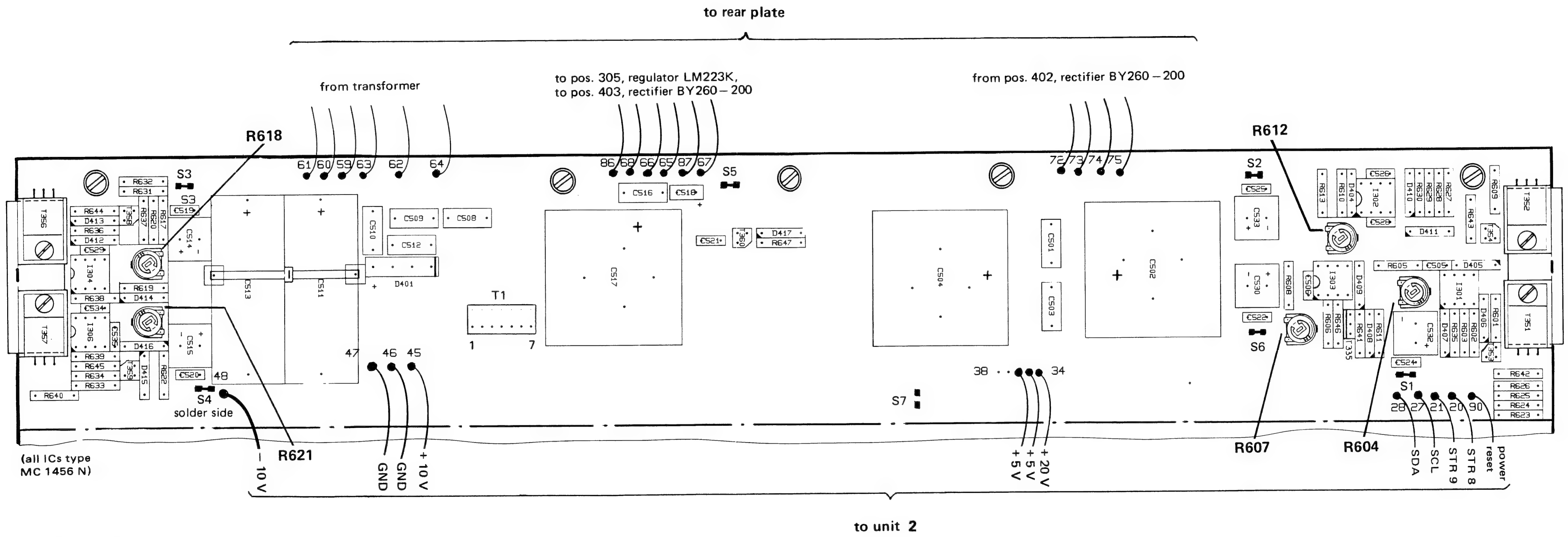
Pos.	Typ	Stromversorg. PIN +5V	GND	DIL
301	MC 3441	16	8	16
302	" "	16	8	16
303	" "	16	8	16
304	" "	16	8	16
305	HEF 4093	14	7	14
306	HEF 4738	40	20	40
307	HEF 40244	20	10	20
308	HEF 40373	20	10	20
309	HEF 4014	16	8	16
310	" "	16	8	16
311	HEF 4094	16	8	16
312	HEF 4514	24	12	24
314	N74LS 363	20	10	20
315	P 2764	28	14	28
317	HCU 04	14	7	14
318	P 8031	40	20	40
319	N 74 LS 390	16	8	16
320	HEF4049	1	8	16
324	PCD 8571		4	8

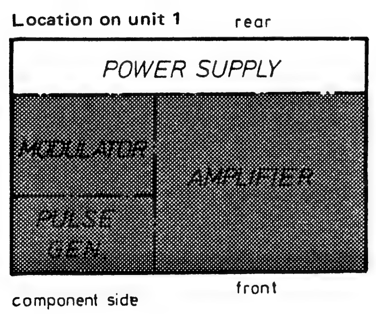
Fig. 38 Unit 2,
CPU (central processing unit)



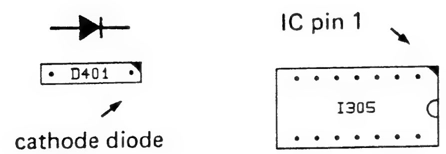
Details see figures 40, 42, 44, 46

Fig. 39 Unit 1,
component lay-out (overview)
power supply
pulse generator
modulator
amplifier



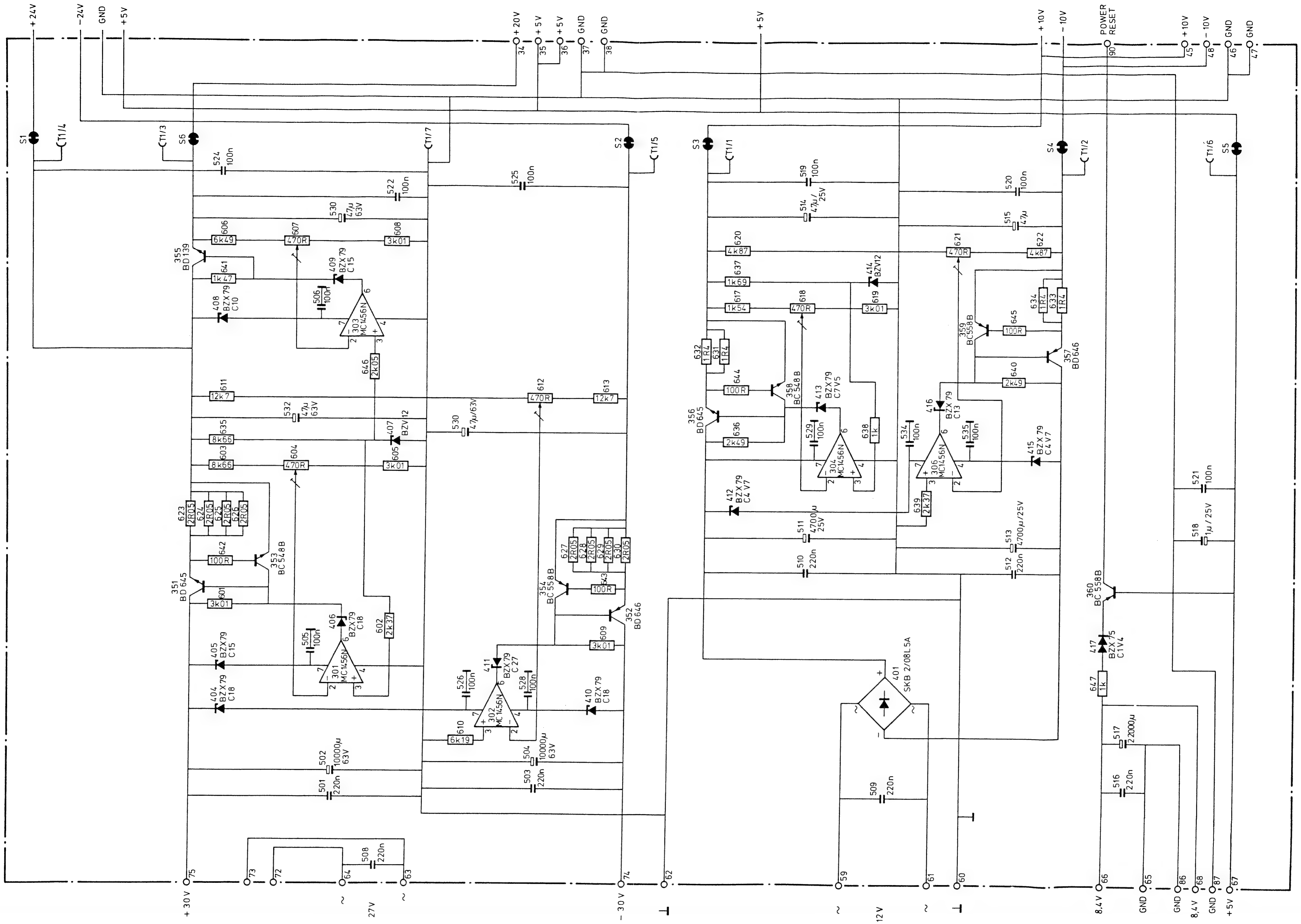


Symbol identification:



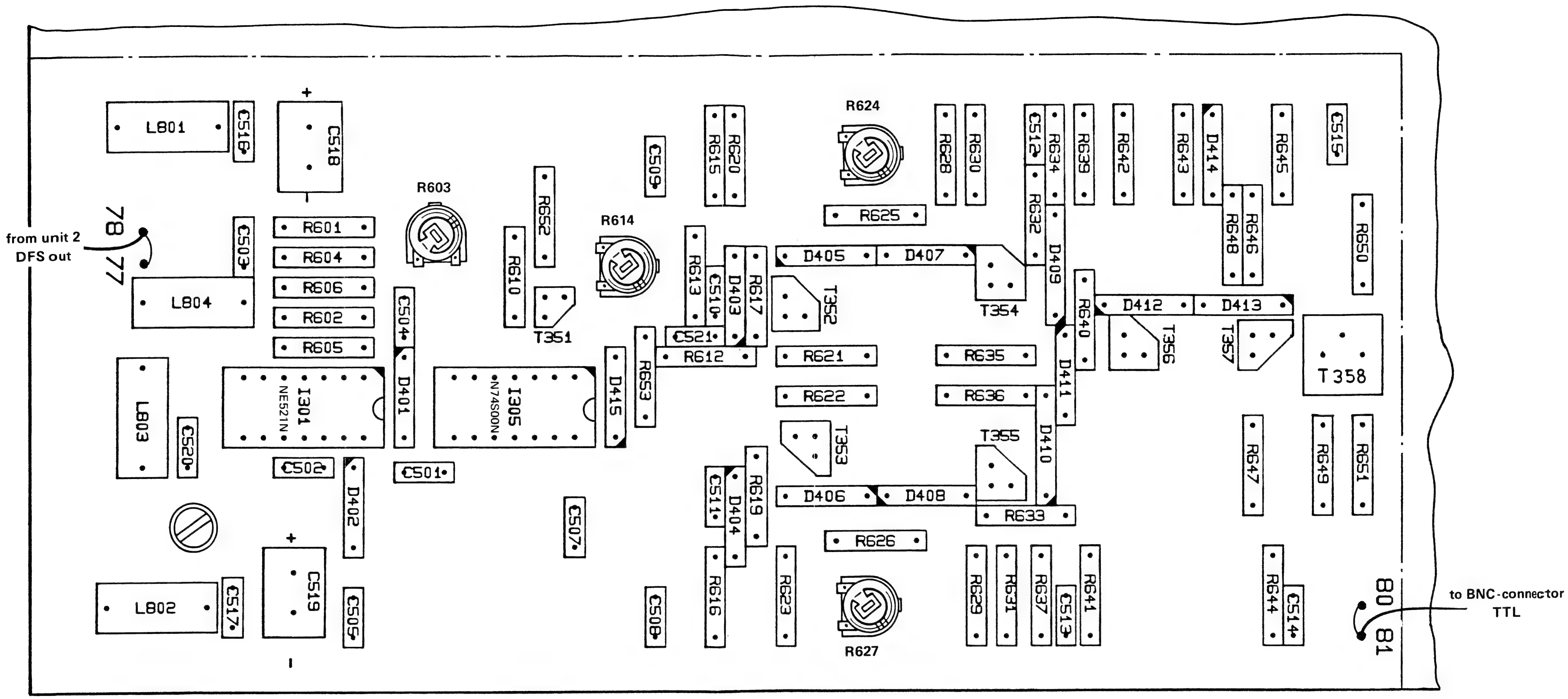
Connections to components mounted on the rear plate, see fig. 33, 'Overall circuit diagram'

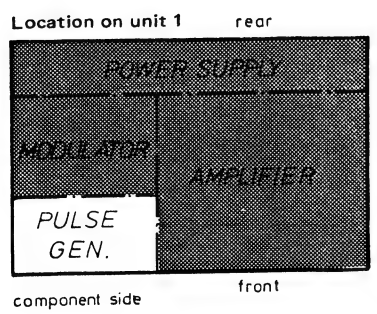
Fig. 40 Unit 1, power supply component lay-out



Connections to components mounted on the rear plate, see fig. 33, 'Overall circuitdiagram'

Fig. 41 Unit 1, power supply





Symbol identification:

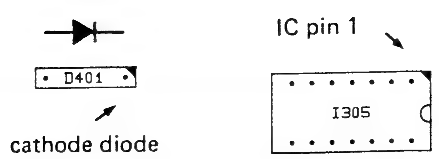


Fig. 42 Unit 1, pulse generator component lay-out

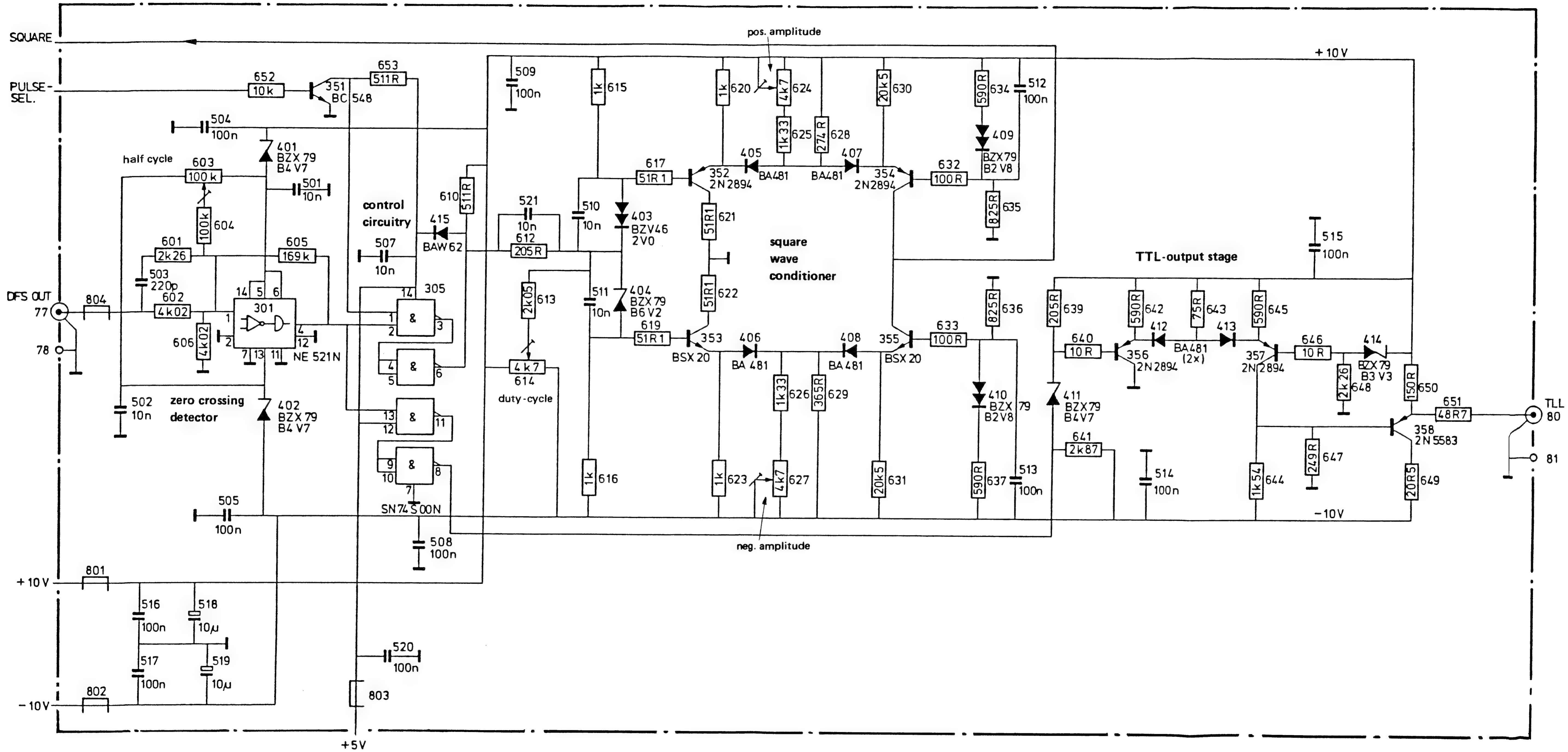


Fig. 43 Unit 1, pulse generator

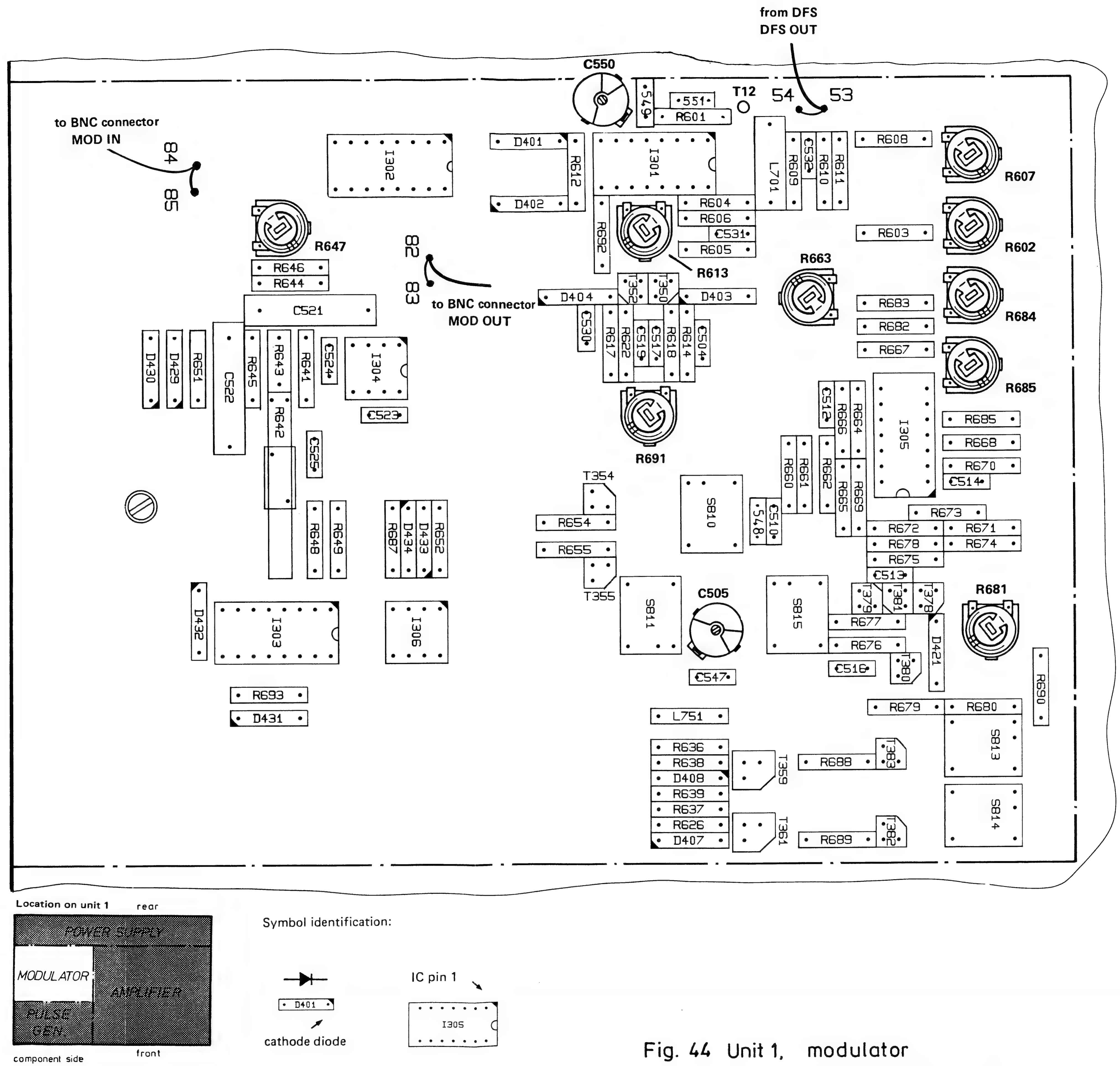
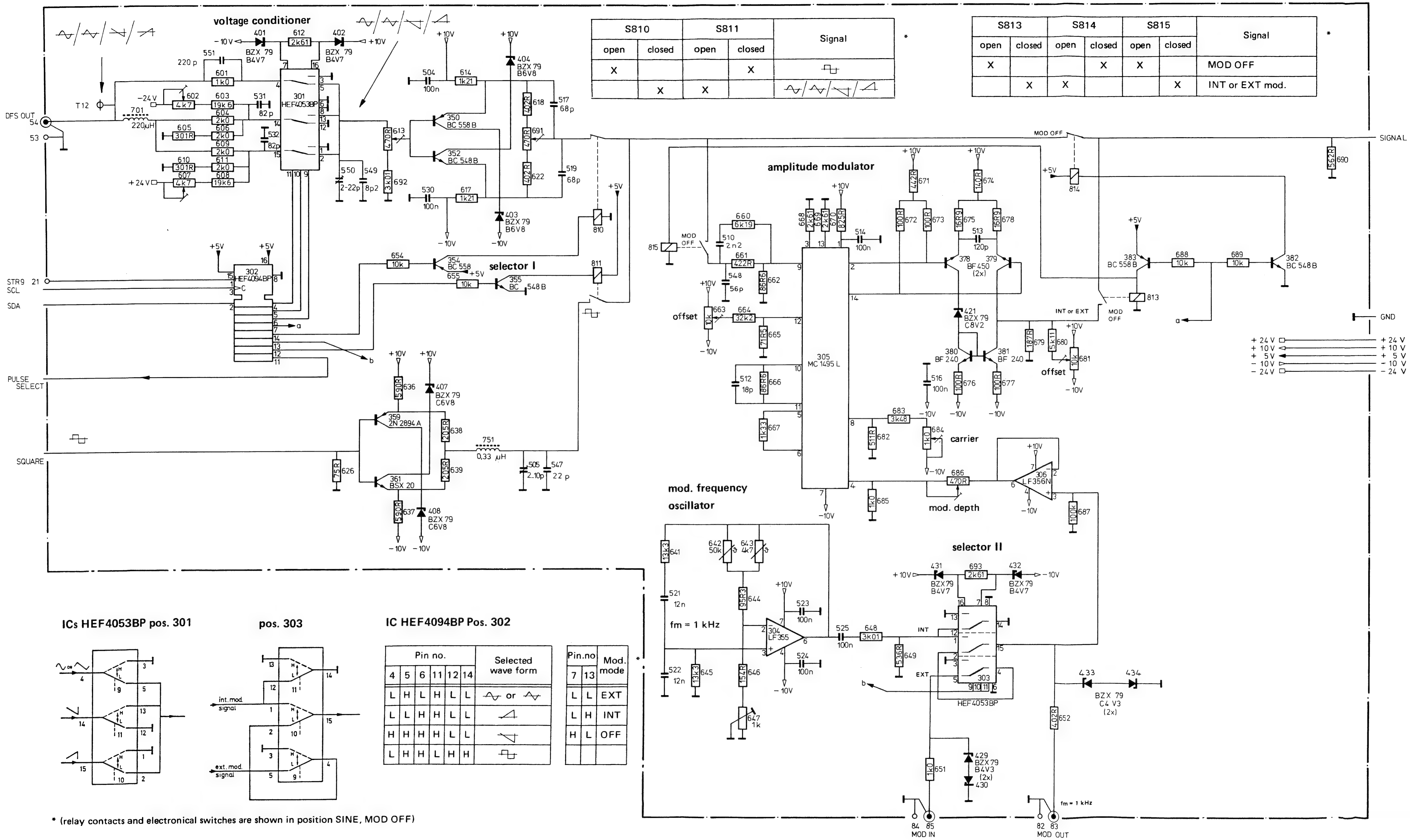


Fig. 44 Unit 1, modulator component lay-out



S810 open	S810 closed	S811 open	S811 closed	Signal
X			X	
	X	X		

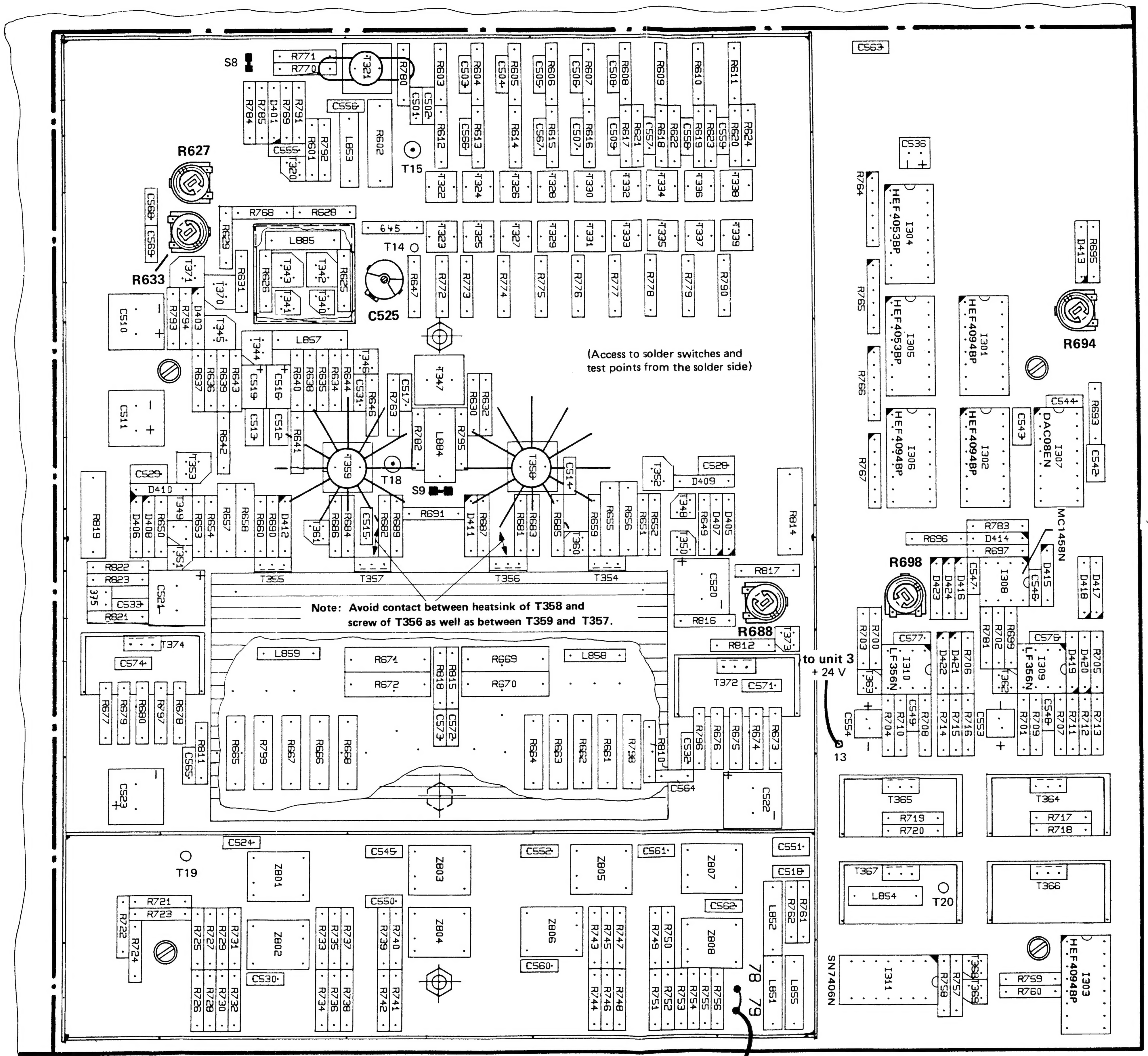
S813 open	S813 closed	S814 open	S814 closed	S815 open	S815 closed	Signal
X			X	X		MOD OFF
	X	X			X	INT or EXT mod.

Pin no. 4	5	6	11	12	14	Selected wave form
L	H	L	H	L	L	or
L	L	H	H	L	L	
H	H	H	H	L	L	
L	H	H	L	H	H	

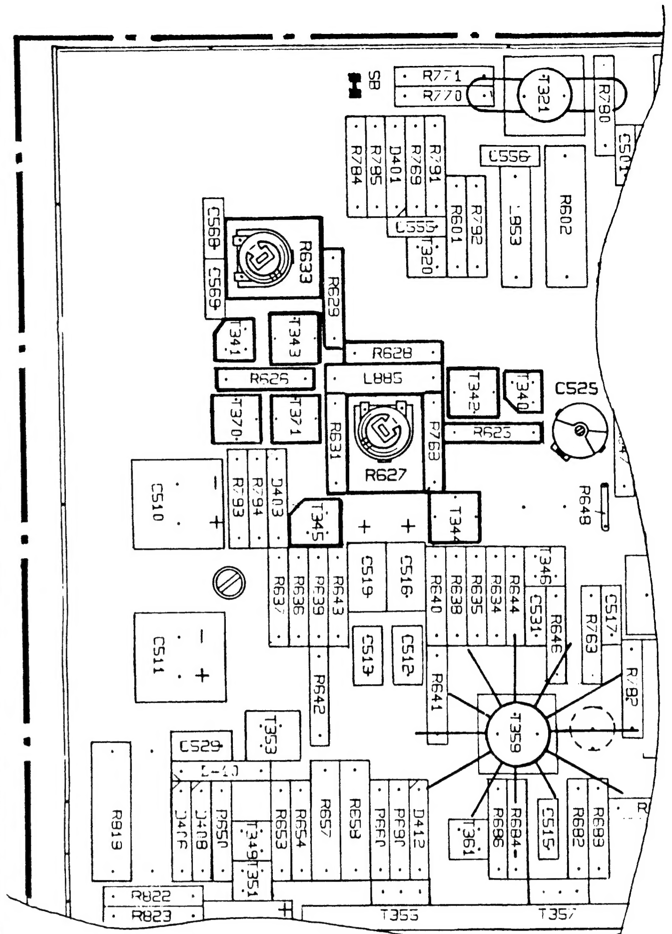
Pin.no 7	13	Mod. mode
L	L	EXT
L	H	INT
H	L	OFF

* (relay contacts and electronical switches are shown in position SINE, MOD OFF)

Fig. 45 Unit 1, modulator

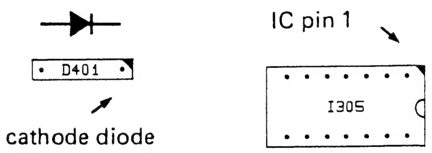


Component lay-out from ser. no. LO - 00790 onwards



Component lay-out up to ser. no. LO - 00789

Symbol identification



Location on unit 1

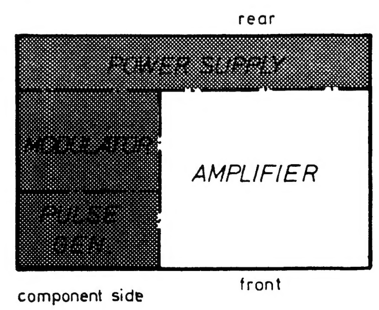
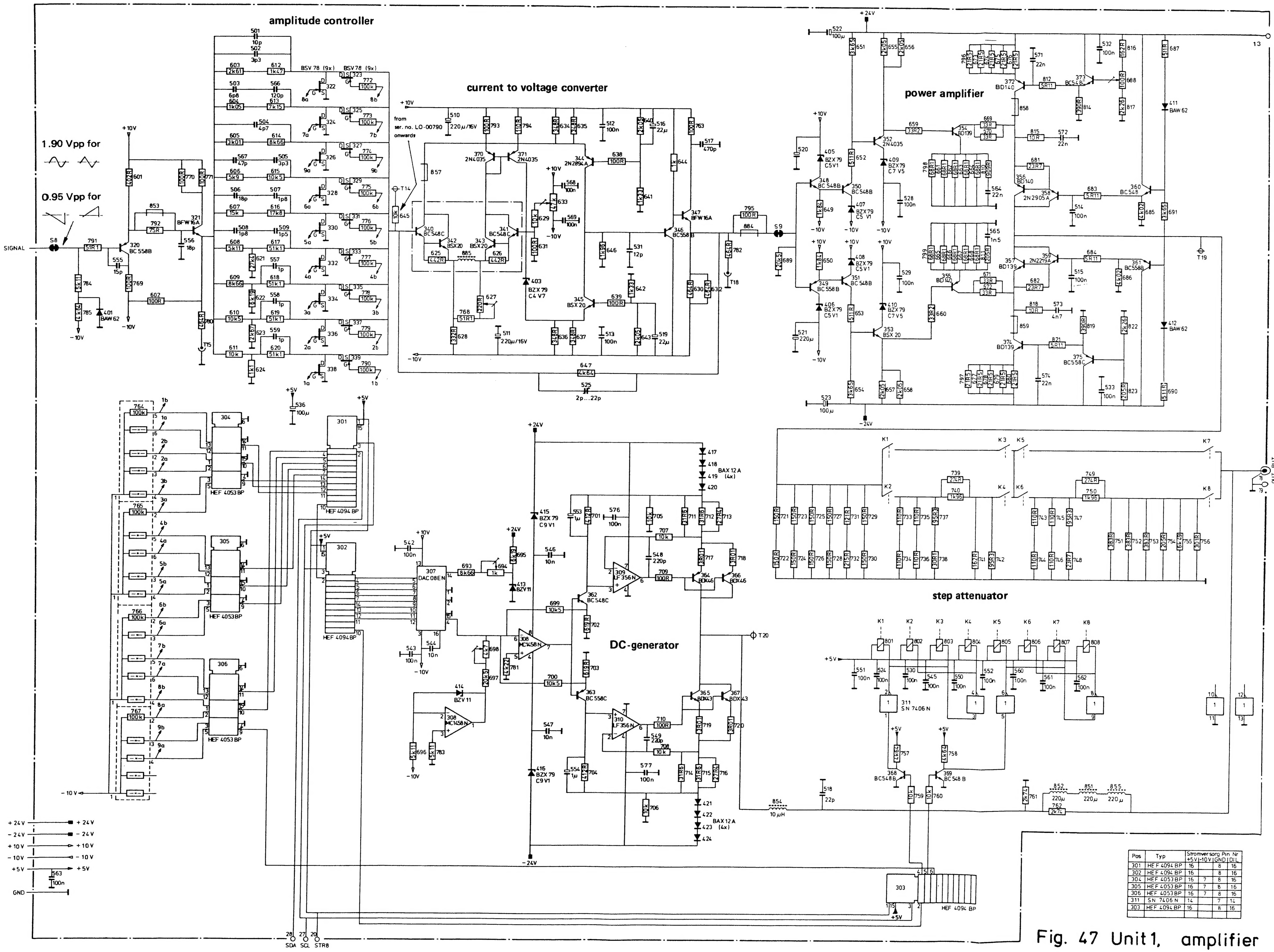


Fig. 46 Unit 1, amplifier component lay-out



Pos	Typ	Stromversorg Pin Nr +5V	-10V	GND	DIL
301	HEF 4094 BP	16		8	16
302	HEF 4094 BP	16		8	16
304	HEF 4053 BP	16	7	8	16
305	HEF 4053 BP	16	7	8	16
306	HEF 4053 BP	16	7	8	16
311	SN 7406 N	14		7	14
303	HEF 4094 BP	16		8	16

Fig. 47 Unit1, amplifier

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① *Country*	② *Day Month Year*	③ *Typenumber /Version*	④ *Factory/Serial no.*
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2	D 0 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ [ ][ ][1][2] Hrs

Detailed description of the information to be entered in the various boxes:

①Country: [3 2] = Switzerland

②Day Month Year [1 5 0 4 7 5] = 15 April 1975

③Type number/Version [0 P M 3 2 6 0 0 2] = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number [D 0 0 0 7 8 3] = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

[ ][ ][ ][ ]

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

[ ][ ][ ][ ][ ][ ]

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric,the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve,transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

[ ]

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

[ ][ ][1][2] = 1,2 working hours (1 h 12 min.)

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